

UNCLASSIFIED

AD NUMBER	
AD155208	
CLASSIFICATION CHANGES	
TO:	UNCLASSIFIED
FROM:	CONFIDENTIAL
LIMITATION CHANGES	
TO: Approved for public release; distribution is unlimited.	
FROM: Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; JAN 1958. Other requests shall be referred to Department of the Army, Aberdeen Proving Ground, MD.	
AUTHORITY	
APG ltr 19 Nov 1980 ; APG ltr 19 Nov 1980	

THIS PAGE IS UNCLASSIFIED

THIS REPORT HAS BEEN DELIMITED  
AND CLEARED FOR PUBLIC RELEASE  
UNDER DOD DIRECTIVE 5200.20 AND  
NO RESTRICTIONS ARE IMPOSED UPON  
ITS USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE,  
DISTRIBUTION UNLIMITED.

UNCLASSIFIED

AD 155208

CLASSIFICATION CHANGED

TO: UNCLASSIFIED

FROM CONFIDENTIAL

AUTHORITY:

APG, D/A etc,

19 NOV 80.



UNCLASSIFIED

UNCL

IFIED

AD

155 208

FOR  
MICRO-CARD  
CONTROL ONLY

Reproduced by

Armed Services Technical Information Agency

ARLINGTON HALL STATION; ARLINGTON 12 VIRGINIA

REPRODUCED FROM

**"NOTICE: When Government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the U.S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto."**

AD No 155208

ASTIA FILE COPY

CONFIDENTIAL

FC  
BAC



Aberdeen Proving Ground

MARYLAND

DEVELOPMENT AND PROOF SERVICES

Report

OCO Project No.

Regd

58 AA

3345

CONFIDENTIAL

**CONFIDENTIAL**

DEVELOPMENT AND PROOF SERVICES  
ABERDEEN PROVING GROUND  
MARYLAND

AUTHORITY: ORDBG

Mr RHallen/eh  
23 January 1958

ACCURACY AND ARMOR DEFEATING EVALUATION OF

SHELL, HEP, 155MM, T152E5 AND T152E6 (U)

SEVENTH REPORT ON ORDNANCE CORPS PROJECT NO. TAL-5002H

DATES OF TEST: 26, 27, 28 MARCH; 10, 11, 27 APRIL; 4 MAY; 25 JUNE 1957

ABSTRACT

OBJECTIVE

To determine and compare the accuracy, armor defeating capabilities and effective maximum range of two different designs of Shell, HEP, 155mm.

SUMMARY

A number of Shell, HEP, 155mm, inert- and Composition A-3-loaded, were fired to evaluate differences between two designs. Both designs were fired alternately for accuracy, defeat of armor, and maximum range. A comparative panel fragmentation test was conducted with the two designs and the standard HE, M107, Shell.

CONCLUSIONS

The Shell, HEP, 155mm, T152E5 is superior to Shell, HEP, 155mm, T152E6 in accuracy and armor-defeating qualities.

RECOMMENDATIONS

It is recommended that:

- A. Shell, HEP, 155mm, T152E5 be considered superior to Shell, HEP, 155mm, T152E6 for the defeat of armor.
- B. Consideration be given to redesign of the shell incorporating a point-detonating, mechanical time or VT fuze in combination with a base-detonating fuze for air burst against personnel, in addition to its armor-defeating qualities.
- C. Additional studies be made with the T152E5 Shell for possible employment in the 155mm, ML, Gun, with respect to maximum range determination, defeat of armor and bunkers, and accuracy up to 2000 yards.
- D. An evaluation of the standard M141 Charge be made in conjunction with the T152E5 Shell in an attempt to eliminate requirements for a special charge.

58 AA

3345 CONFIDENTIAL

APR 3 1958

## CONTENTS

	<u>PAGE NO.</u>
INTRODUCTION . . . . .	3
DESCRIPTION OF MATERIEL. . . . .	3
DETAILS OF TEST. . . . .	3
CONCLUSIONS. . . . .	8
RECOMMENDATIONS. . . . .	8
APPENDIX A: CORRESPONDENCE. . . . .	A-1
APPENDIX B: FIRING RECORD . . . . .	B-1
APPENDIX C: PHOTOGRAPHS . . . . .	C-1
APPENDIX D: PLOTS OF TARGET ACCURACY. . . . .	D-1
APPENDIX E: STARGAGE REPORTS, METEOROLOGICAL REPORTS, METALLURGICAL REPORT. . . . .	E-1
APPENDIX F: DRAWING OF FUZE AND SHELL . . . . .	F-1
APPENDIX G: DISTRIBUTION. . . . .	G-1

## CONFIDENTIAL

### I INTRODUCTION

A. Previous firing of the 155mm, HEP, Shell in the 155mm, M1, Howitzer gave indication of good band engraving with no distortion of the shell body at pressures up to 35,000 psi and an average muzzle velocity of 2300 fps. It was evident from the limited test results that a heavier shell wall as well as a positive means of sealing the base plug were needed.

B. The two designs fired in this test incorporated the desired modifications to correct the above-mentioned deficiencies. Both designs that were live-loaded were assembled with a BD, T-, Adjustable, Fuze (firing pin was adjustable) which was similar to the standard Fuze, BD, M91A1.

### II DESCRIPTION OF MATERIEL

A. Shell, HEP-T, Inert-Loaded, 155mm, T152E5 with Fuze, BD, M91A1, Inert-Loaded, with Live Tracer, Lot PA-E-23878. The thickness of the shell wall was .115-inch to .170-inch at the beginning of the ogive.

B. Shell, HEP-T, Inert-Loaded, 155mm, T152E6, with Fuze, BD, M91A1, Inert-Loaded, with Live Tracer, Lot PA-E-23879. The thickness of the shell wall was .220-inch to .265-inch at the beginning of the ogive.

C. Shell, HEP, Composition A-3-Loaded, 155mm, T152E5 with Fuze, BD, T-, Adjustable, Lot PA-E-23880.

D. Shell, HEP, Composition A-3 Loaded, 155mm, T152E6 with Fuze, BD, T-, Adjustable, Lot PA-E-23881.

E. Shell, HE, TNT-Loaded, M107, with supplementary charge, with Fuze, PD, M51A5, Lot WC-31-82. This shell was used as a standard between the T152E5 and T152E6 live-loaded shell in maximum range and fragmentation tests.

F. For photographs of both shell designs with charges see Appendix C, Photograph Nos. B24565 - B24566. Also Appendix F, Drawing of Fuze and Shell.

### III DETAILS OF TEST

#### A. PROCEDURE

1. Since the test program consisted of an evaluation between 2 shell designs, the test was divided into 4 phases. These phases were:

- a. Defeat of armor plate at 400 feet.
- b. Accuracy determination.
- c. Defeat of armor plate at 1000 yards.
- d. Maximum range and dispersion. All rounds were fired from a standard field carriage (M1A1).

## CONFIDENTIAL

2. The first phase of the test was the defeat of armor plate with live-loaded ammunition at approximately 400 feet. To accomplish this, two 8-inch armor plates were fired at, one set at 0° obliquity and the other at 60° obliquity. When it was found that the 8-inch plate at 0° obliquity could be defeated, firing at the 8-inch plate set at 60° obliquity was started. This plate could not be defeated and a 7-inch plate set at 60° obliquity was substituted. It was possible to defeat this plate. Following the plate firing, several rounds were then fired at a German "King Tiger" tank hull having 6-inch armor arranged at 44° obliquity.

3. The second phase of the test was the firing of shell of both designs inert-loaded at a 1000-yard target for the determination of accuracy. Three groups of the T152E5 design and one group of the T152E6 design were fired. During the firing for accuracy the howitzer was kept in alignment by the use of 2 transits which controlled the vertical and horizontal azimuth of the tube.

4. The third phase of the test was the setting of armor plate that was defeated at 400 feet at 1000 yards range. All shell in this phase were live-loaded. The 8-inch plate was set at 0° obliquity and the 7-inch plate at 60° obliquity. The shell designs were fired alternately to give a round-by-round comparison. A second German "King Tiger" tank hull was placed at 1300 yards from the muzzle to determine the long-range effect of the HEP shell against armor of this type.

5. The fourth phase of the test was to determine the maximum range and dispersion of both shell designs in comparison with Standard, HE, M107, 155mm Shell. All rounds were live-loaded and were fired at 45° elevation. The standard, HE, M107, Shell were fired first followed by the T152E5 and T152E6 shell.

6. In addition to the 4 phases, a panel fragmentation test was conducted utilizing 2 shell of each design and 2 standard Shell, HE, M107. A chemical and metallurgical analysis of the frontal plate of the German "King Tiger" tank hull was also conducted.

### B. RESULTS

1. The firing of phase a was with live-loaded shell against armor plate at approximately 400 feet from the muzzle of the howitzer. Prior to the firing, the fuzes of 8 of the live-loaded shell, 4 each of T152E5 and T152E6 were adjusted as follows:

<u>NUMBER ADJUSTED</u>	<u>SHELL</u>	<u>LENGTH OF PLUNGER TRAVEL(inches)</u>
2	T152E5	.30
2	T152E5	.45
2	T152E6	.30
2	T152E6	.45

a. The adjustment was made to determine which length of fuze plunger setting would give the optimum bursting effect when used against armor plate. After setting the fuze manually, a thread setting cement similar to "Laminac" was poured on the thread of the adjusting screw and permitted to harden prior

**CONFIDENTIAL**

to firing. Four of the rounds, 2 of each design, one set at .30-inch and the other at .45-inch, were then fired at a 8-inch plate set at 60° obliquity. Complete spalls resulted from all 4 shell. The remaining 4 shell were set at .30-inch and .45-inch and then fired against a similar 8-inch plate set at 60° obliquity. The hits upon this plate resulted in bulges for both shell designs. Although the bulges were of similar magnitude for both shell, 2 had partial cracks at the base. From these 8 rounds it was determined that a fuze setting of .30-inch plunger travel would produce satisfactory shell performance and all the remaining live-loaded HEP shell of both designs were set accordingly.

b. Twenty more shell, 10 each of Designs T152E5 and T152E6, were then fired alternately at the 8-inch plate set at 0° obliquity. Of the 20 rounds fired, 6 rounds functioned low order. One of the shell, Round Number Eight, functioned low order, which produced a bulge on the rear of the plate. The other 14 rounds resulted in complete spalls. Ten rounds, 5 of each design, were then fired alternately at a 7-inch plate set at 60° obliquity. All rounds functioned high order and resulted in complete spall. A German "King Tiger" tank hull which had a main front plate, 6-inches thick, set at 44° obliquity, was then fired at to determine the effect of the HEP shell against foreign armor.

c. The first shell fired, Design T152E5, resulted in a complete spall. The weight of this spall was approximately 87 pounds. See Appendix C, Photograph B-24856. The second shell, Design T152E6, also resulted in a complete spall. This spall was not weighed. The third shell, Design T152E5, struck the junction of the upper and lower glacis plate which was also 6-inches thick. Although the spall was very small compared to the others the entire weld between both plates as well as the welds in the front area were completely fractured. See Appendix C, Photograph B-24582 - B-24585.

2. The firing of phase b was conducted for accuracy determination. This firing was begun with the T152E5 shell design. Due to the target distance, it was difficult to estimate the proper elevation which would give a good hit. The first round was fired at 32 mils elevation. Five other rounds were fired dropping the elevation each time until a hit occurred. It was noted that during the first few conditioning and sensing rounds the field carriage trails moved rearward until the carriage became firmly fixed in the ground. After this there was no other perceptible movement either laterally or horizontally.

a. A 10-round series of the T152E5 shell was then fired, which gave a lateral probable error of .27 mils and a vertical probable error of .39 mils. This corrects to a vertical probable error of .13 mils if round 3 and 4 are omitted from the computations. A second 10-round series of the T152E5 shell was then fired, which resulted in a lateral probable error of .32 mils and a vertical probable error of .34 mils. A 10-round group of the T152E6 shell was then fired, which gave a lateral probable error of .34 mils and a vertical probable error of .14 mils. Following the T152E6 Shell, a 5-round group of the T152E5 shell was fired which gave a lateral probable error of .11 mils and a vertical probable error of .31 mils. The vertical probable error corrects to .09 mils if the fifth round fired is omitted from the computations. See Appendix D, Plots of Target Accuracy.

**CONFIDENTIAL**

3. For the third phase, phase c, the armor plates that were defeated at approximately 400 feet were set up at 1000 yards from the muzzle of the howitzer. The first plate fired at was an 8-inch plate set at 0° obliquity. The firing was begun with a T152E5 Shell and the shell were alternated in order to compare fuze action and the degree of spalls. The first round went over the plate but the second round, a T152E6 Shell, hit. The next 3 rounds, 2 T152E5 and one T152E6, hit the plate and gave good spalls. Round Six, T152E6, hit the plate but functioned low order. The seventh round, T152E5, fell short of the plate but functioned perfectly. Upon examination to determine why the shell failed to reach the plate it was found that the jacking plate of the field carriage had sunk approximately one inch into the ground. The gun was then re-boresighted before firing. Upon firing Round Eight, T152E6, the shell struck the forward edge of the 5-inch spatter plate. See Appendix C, Photograph B22049. The round functioned high order and produced laminations on the face which were 14 inches long with a measurable center depth of 7 inches. Rounds Nine through Thirteen, 3 T152E5 and 2 T152E6 shell, gave complete back spalls on the plate. A second German "King Tiger" tank hull was placed 1300 yards from the muzzle and a T152E5 shell was fired at it. A direct hit was scored on the main front plate with a resulting 14 x 18 1/2 back spall 2 inches deep. The hit, which was high order, fractured all the welds on the main front plate as well as the welds on both sides. The hull was moved backwards 5 feet from the prefiring position. It was decided that any further firing on the hull would fail to yield useful information, as the damage was too extensive. See Appendix C, Photographs B22005-B22009, B22045-B22049, B24635-B24638.

a. A 7-inch plate was then placed at a 1000 yards from the muzzle at 60° obliquity. The bottom edge of the plate was dug into the ground and the top edge supported by an M36 Gun Motor Carriage. The first round fired, a T152E5 shell, missed the plate but the second and third rounds, T152E6 and T152E5, hit the plate. The second round struck the top edge and broke part of the plate away. The third round spalled the plate. The gun shifted on firing the fourth round and the Shell, T152E6, missed the top of the plate and impacted on the base of the turret of the M36 Gun Motor Carriage. This round functioned high order and blew the top of the turret off the carriage causing the carriage to burn with complete destruction to the motor and related components within the carriage. (See Appendix C, Photographs B24755 to B24760.) It is estimated that the turret of the M36, Motor Carriage with the extra side plates weighed approximately ten to fifteen tons.

b. Although it was questionable whether to continue firing (as the ground was soft, which permitted movement of the field mount) it was decided to continue firing. The next 3 rounds were 2 T152E5 shell and a T152E6 which functioned high order. Rounds Five and Seven failed to give complete spalls, but the bulges of both rounds had cracks that partially encircled the base. Round Six gave a complete spall. Round Eight, a T152E6 shell, hit adjacent to Round Six and was low order and no bulge or spall resulted. Round Nine, a T152E5 shell, impacted high order in the vicinity of Round Seven and did not bulge or spall. It is believed that the previous hits on the plate where either bulges or spalls occurred caused that area of the plate to be laminated and the next hit in the vicinity of the laminations absorbed part of the shock wave. It was found that in some of the spalls on this plate that small flat pieces of the plate could be picked out and other pieces of the plate inside

# CONFIDENTIAL

the spalled area could be moved. (See Appendix C, Photograph B25726.) Rounds Ten, Eleven and Twelve, 2 T152E6 and one T152E5 shell, gave satisfactory back spalls on the plate. The size of the spalls on this plate were smaller than those previously encountered, but the charpy value of 103.77 - 91.46 for the plate was much higher than on previous plates fired. (See Appendix C, Photographs B-24755-60 and B25724-26.)

4. In the fourth phase, for maximum range and dispersion, all rounds were live-loaded and fired at 45° elevation. The first rounds fired were a group of 10-rounds Shell, HE, M107, which were assembled with a standard point-detonating fuze. This group was followed by 12 rounds of T152E5 shell and 8 rounds of T152E6 shell. The results of this firing were:

PROJECTILE	MUZZLE VELOCITY(fps)		RANGE (yards)		TIME OF FLIGHT (sec.)	
	AVERAGE	STD. DEV.	AVERAGE	STD. DEV.	AVERAGE	STD. DEV.
M107	1837	6.36	15918	59.71	59.50	0.58
T152E5	1829	2.94	11302	95.14	52.23	0.57
T152E6	1831	3.70	11865	57.52	53.20	0.20

5. A chemical and metallurgical analysis of a section of the "King Tiger" main frontal plate was made. It was determined that the plate was of relatively poor quality and therefore, the armor was ineffective against this type of round. (See Appendix E, Metallurgical Report No. 57-P-45.)

6. The preliminary results of the panel fragmentation test show a high degree of fragmentation with high velocity from the nose and side spray of both shell. In an evaluation of the size of fragments and the velocities of both HEP shell and the HE, M107, the T152E5 design was superior. It is felt that the T152E5 shell might be modified to incorporate a point-detonating, mechanical time or VT fuze which would make the shell suitable for airburst against either unsheltered or poorly sheltered personnel. A fuze of the above-mentioned type could be assembled to the shell by means of a standard adapter ring mounted internally as the forward end of the ogive. A dummy fuze with a suitable nose pad could be assembled to the shell if it was desired to have HEP action. A base-detonating fuze would remain as an integral part of the shell. Considerable production time and cost would be saved as the current operation for the construction and manufacture of the nose of the HEP shell requires several operations.

7. Since the number of rounds of both shell designs were limited in quantity, further evaluation of the shell was restricted. Had the supply been adequate, it would have been advantageous to compare the velocity and range of both shell designs with the HE, M107 in firing with the standard M4A1, Zone 7 Charge. However, it was calculated from the results of the range firing phase that the T152E5 and E6 shell if used with the M4A1 charge would give the following increase in velocity and range:

PROJECTILE		EXPECTED MUZZLE VELOCITY (fps)	EXPECTED PRESSURE psi/100	EXPECTED RANGE (yards)
TYPE	WEIGHT (lbs)			
T152E5	71.0	2151	241	14,052
T152E6	78.0	2051	251	13,705

**CONFIDENTIAL**

8. Copies of the panel fragmentation report with the firing record will be distributed at a later date.

IV CONCLUSIONS

It is concluded that:

The Shell, HEP, 155mm, T152E5 is superior to Shell, HEP, 155mm, T152E6 in accuracy and armor-defeating qualities.

V RECOMMENDATIONS

It is recommended that:

A. Shell, HEP, 155mm, T152E5 be considered superior to Shell, HEP, 155mm, T152E6 for the defeat of armor.

B. Consideration be given to redesign of the shell incorporating a point-detonating, mechanical time or VT fuze in combination with a base-detonating fuze for air burst against personnel, in addition to its armor-defeating qualities.

C. Additional studies be made with the T152E5 Shell for possible employment in the 155mm, ML, Gun, with respect to maximum range determination, defeat of armor and bunkers, and accuracy up to 2000 yards.

D. An evaluation of the standard M41 Charge be made in conjunction with the T152E5 Shell in an attempt to eliminate requirements for a special charge.

SUBMITTED:

*Ralph H. Allen*  
RALPH H. ALLEN  
Proof Director

REVIEWED:

*H. B. Anderson*  
H. B. ANDERSON  
Chief, Artillery  
Ammunition Branch

*H. A. Bechtol*  
H. A. BECHTOL  
Chief, Artillery Division

APPROVED:

*H. A. Noble*  
H. A. NOBLE  
Assistant to the Deputy Director  
for Engineering Testing  
Development and Proof Services

## APPENDICES

	<u>PAGE NO.</u>
APPENDIX A: CORRESPONDENCE. . . . .	A-1
APPENDIX B: FIRING RECORD . . . . .	B-1
APPENDIX C: PHOTOGRAPHS . . . . .	C-1
APPENDIX D: PLOTS OF TARGET ACCURACY. .	D-1
APPENDIX E: STARGAGE REPORTS, METEOROLOGICAL REPORTS, METALLURGICAL REPORT. . . .	E-1
APPENDIX F: DRAWING OF FUZE AND SHELL .	F-1
APPENDIX G: DISTRIBUTION. . . . .	G-1

**CONFIDENTIAL**  
ORDNANCE CORPS  
**PICATINNY ARSENAL**  
DOVER, NEW JERSEY

APPENDIX A

Mr. T. Clifford/bjb/2269

FEB 11 57 -11 AM

IN REPLY  
REFER TO:

ORDBB-TE5

470 (741-80034) 155 mm

SUBJECT: Test Program Request Nr. TE-20, Accuracy and Armor  
Defeating Evaluation of Shell, HEP, 155mm, T152E5  
and T152E6 (U)

TO: Commanding General  
Aberdeen Proving Ground  
Aberdeen, Maryland  
ATTENTION: ORDBG-DP-TA (Mr. H. B. Anderson)

1. Inclosed is Test Program Request Nr. TE-20, D/A  
Priority 1B, for testing of 135 subject shell. These shell  
with bagged propelling charges, the description of which is  
furnished in the inclosed Test Program Request, are scheduled  
for shipment to your Proving Ground during the week of 28  
January 1957. Ammunition Data Cards Nrs. 83332, 83333, 83334,  
and 83335, in triplicate, covering the subject shell and Draw-  
ing P-87758, dated 12 September 1955, in duplicate, covering  
the Fuze, BD, T-, Adjustable, used in the Composition A-3  
loaded shell, are inclosed for your information and file.

2. Funding Data:

Funds are available under Sub-Project Order Number  
70405530-01-10201-01, and Job Order Number 3039-99-901.

3. Coordination:

- a. OGO - CRDTA
- b. APG - Artillery Ammunition Branch, ORDBG-DP-TA
- c. Picatinny Arsenal - Engineer primarily responsi-  
ble for the test is Mr. T. Clifford, phone: Picatinny Arsenal,  
Extension 2269.

A-1

15251

"REGRADED UNCLASSIFIED WHEN SEPARATED FROM INCLOSURE"  
**CONFIDENTIAL**

c444

**CONFIDENTIAL**

ORDBB-TE5

SUBJECT: Test Program Request Nr. TE-20, Accuracy and Armor  
Defeating Evaluation of Shell, HEP, 155mm, T152E5  
and T152E6 (U)

4. Notification for Test Attendance:

Mr. T. Clifford will attend the test, and requests  
notice three days prior to the firing.

FOR THE COMMANDER:

*R. H. Wood*  
R. H. WOOD  
Assistant

✓ 6 Incls

1. TPR Nr. TE-20 (C) *add 1 copy for APS-PP -  
(six copies) add 1 copy for Coare + add 1 copy in HQ NTR,*

2-5. Ammo Data Cards Nrs.  
83332, 83333, 83334,  
83335 (in Trip)

6. Dwg. P-87758 (in Dupe)

CC

OCO-ORDTA w/Incls 1-6

Chamberlain Corporation w/Incl 1

100 Mildred Street

Waterloo, Iowa

APG-Comptrollers Office

A-2

**CONFIDENTIAL**

"REGRADED UNCLAS" SINCE ALL INFORMATION CONTAINED HEREIN IS UNCLASSIFIED

**CONFIDENTIAL**

Mr. T. Clifford/bjb/2269  
Test Program Request Nr. TE-20(C)  
(Job Order Nr. 3039-99-901)  
Picatinny Arsenal, Dover, N. J.  
29 January 1957

*Shell 1 (ordn) 9/11/46*

1. Material for Test:

- a. 34 each Shell, HEP-T, Inert-Loaded, 155mm, T152E5, with Fuze, BD, M91A1, Inert-Loaded with Live Tracer, Lot PA-E-23878.
- b. 11 each Shell, HEP-T, Inert-Loaded, 155mm, T152E6, with Fuze, BD, M91A1, Inert-Loaded with Live Tracer, Lot PA-E-23879.
- c. 48 each Shell, HEP, Comp A-3 Loaded, 155mm, T152E5, with Fuze, BD, T-, Adjustable, Lot PA-E-23880.
- d. 42 each Shell, HEP, Comp A-3 Loaded, 155mm, T152E6, with Fuze, BD, T-, Adjustable, Lot PA-E-23881.
- e. 82 each Charge, Propelling, T-, for 155mm Howitzer, Projectile, HEP, T152E5, Lot PA-E-24685.
- f. 53 each Charge, Propelling, T-, for 155mm Howitzer, Projectile, HEP, T152E6, Lot PA-E-24684.

2. Project Authority:

- a. Ordnance Project Number TA1-5002H.
- b. Department of the Army Number 5A04-01-001.
- c. Funds available under Sub-Project Order Number 70405530-01-10201-01, and Job Order Number indicated above.
- d. D/A Priority 1B.

3. Object of Development or Experiment:

To compare the accuracy and armor defeating capabilities of 155mm, T152E5 HEP Shell (Thin Wall), with T152E6 HEP Shell (Heavy Wall), and to ascertain optimum fuze functioning time for both shell by use of the Fuze, BD, T-, Adjustable.

A-3

REGRAING DATA CANNOT BE PREDETERMINED  
**CONFIDENTIAL**

**CONFIDENTIAL**

Test Program Request Nr. TE-20 (C) (Cont)

4. History Sketch:

On 2 June 1954, the following 155mm, T152E4 HEP Shell were fired from the 155mm Howitzer, M1, at Aberdeen Proving Ground in accordance with TPR-3672:

a. Three shell for recovery at an average chamber pressure of 34,600 PSI and an average muzzle velocity of 2300 fps, range 9500 yards. Recovered shell indicated good band engraving and no distortion.

b. Four shell against 7" thick armor plate of 64 ft.lbs. Charpy impact value at -40°F, resulting in hinged spalls.

On 8 June 1954, the following five 155mm, T152E4 HEP Shell were fired against 7" thick armor plate with a Charpy impact value of 45 to 48 ft.lbs. at -40°F from the 155mm, T80 Gun at Aberdeen Proving Ground, in accordance with TPR-3672:

Nr. 1 - Hit and destroyed velocity coil.

Nr. 2 - Velocity 1148 fps, plate at 0° - Spalled.

Nr. 3 - Velocity 1489 fps, plate at 0° - Spalled.

Nr. 4 - Velocity 1496 fps, plate at 60° - Spalled.

Nr. 5 - Velocity 1231 fps, plate at 60° - Spalled.

The limited results of the above tests appeared to indicate the necessity of controlled mechanical properties in target plates if valid test results are to be expected, and that additional explosive confinement, by means of heavier shell walls, would increase the terminal effectiveness, as had been the case in previous experiments with other caliber shell.

The T152E5 Shell submitted for test under this TPR are similar to the T152E4, with the exception that the flanged base plug and flat copper gasket of the -E4 have been changed to a base plug with a caulking groove and a copper and lead caulked gas check. Weight of empty metal parts for the T152E5 is 38.1 to 38.6 lbs.; weight of charge is 25.7 to 26.1 lbs.; as fired weight is 69.78 to 70.44 lbs.

The T152E6 is similar to the -E5 Model, with the exception of a heavier side wall and ogive. Weight of empty metal

**CONFIDENTIAL**

Test Program Request Nr. TE-20 (C) (Cont)

parts for the T152E6 is 47.3 to 48.6 lbs.; weight of charge is 23.6 to 24.4 lbs.; as fired weight is 77 to 78.3 lbs.

5. Description in Detail of Improvements Made Since Last Proving Ground Test:

Both the -E5 and -E6 Model shell have a new base plug and a caulked copper and lead gas check, described under the History Sketch. This type of base closure has a greater degree of safety than the flat gasket type, since it will effectively maintain its seal against higher chamber pressures.

Both the -E5 and -E6 Shell, Lots PA-E-23880 and -23881 are assembled with Fuze, BD, T-, Adjustable, Drawing P-87758, dated 12 September 1955. Functioning time of these fuzes may be adjusted in the field by setting the length of firing pin travel from .030" to .210", in accordance with instructions contained in Drawing P-87758, Notes D and E.

Propellant charges have been established for both -E5 and -E6 Model shell at this Arsenal. These charges will produce 1850 fps muzzle velocity at an approximate chamber pressure of 30,000 PSI and will be supplied, ready for use, with the shell.

6. Local Tests:

Propellant charge establishment with uniform velocity series firings for both T152E5 and T152E6 Shell has been conducted at this Arsenal during December 1956, using the 155mm Howitzer, M1.

7. Object of Test:

To determine and compare the accuracy, armor defeating capabilities and optimum fuze functioning time for 155mm T152E5 and -E6 HEP Shell.

8. Precautions in Handling and Testing:

The usual precautions in handling and testing of HE loaded experimental 155mm HEP Shell assembled with experimental fuzes should be followed. The Fuze, BD, T-, Adjustable, contains all the safety features of the standard Fuze, BD, M91A1; however, there is a very remote possibility of gas leakage through the adjusting screw threads at the rear of the fuze and

**CONFIDENTIAL**

Test Program Request Nr. TE-20 (C) (Cont)

since this fuze has not previously been used with ammunition fired from a weapon, appropriate safety precautions should be taken.

9. Recommended Test Program:

Fire all shell from the 155mm Howitzer, M1, using the propelling charges supplied. Resultant muzzle velocity of 1850 fps is similar to that of the M107 HE Shell fired with Zone 7 Charge.

a. Fire three groups of ten each Shell, T152E5, Inert-Loaded, Lot PA-E-23878 (total 30) against an accuracy target approximately 16 feet square at 1000-yard range. Record muzzle velocity, chamber pressure, time of flight, and accuracy. Photograph target after each group of ten rounds. The four remaining inert T152E5 Shell of Lot PA-E-23878 may be used as warmers and spotting rounds.

b. Fire one group of ten Shell, T152E6, Inert-Loaded, Lot PA-E-23879, against an accuracy target approximately 16 feet square at 1000-yard range. Record muzzle velocity, chamber pressure, time of flight and accuracy. Photograph target. The one remaining inert T152E6 Shell of Lot PA-E-23879 may be used as a warmer and spotting round.

c. Fire 30 Shell, T152E5, Comp A-3 Loaded, Lot PA-E-23880, and 30 Shell, T152E6, Comp A-3 Loaded, Lot PA-E-23881, against armor plate of specified thickness and obliquity, having a Charpy impact value of 35 to 50 ft.lbs., at -40°F at an approximate range of 100 yards.

Shell, HEP, T152E5, Lot PA-E-23880

<u>Nr. Shell</u>	<u>Plate Thickness</u>	<u>Obliquity</u>
5	8"	0°
5	7"	0°
5	6"	0°
5	8"	60°
5	7"	60°
5	6"	60°

A-6  
**CONFIDENTIAL**

REGRADE DATA CANNOT BE PREDETERMINED

**CONFIDENTIAL**

Test Program Request Nr. TE-20 (C) (Cont)

Shell, HEP, T152E6, Lot PA-E-23881

<u>Nr. Shell</u>	<u>Plate Thickness</u>	<u>Obliquity</u>
5	8"	0°
5	7"	0°
5	6"	0°
5	8"	60°
5	7"	60°
5	6"	60°

When plate of a specified thickness and obliquity is defeated by a series of five shell, five additional confirming shell will be fired against the same plate, and firings against thinner plates at the same obliquity cancelled. Record the following data for each shell:

- (1) Muzzle velocity
- (2) Striking velocity
- (3) Facial impression dimensions
- (4) Spall size, weight and velocity
- (5) Recover and photograph spalls
- (6) Photograph front and back of target plate
- (7) Photograph one each T152E5 and -E6 Shell with propelling charge prior to firing.

Setting of fuze functioning time for Comp A-3 Loaded shell will be demonstrated by Picatinny Arsenal representative who will furnish thread sealing cement specified on Drawing P-87758. Prints of this drawing, in duplicate, will be supplied the Proving Ground.

Shell must be conditioned at a minimum temperature of 70°F prior and during application of thread sealing compound.

A-7  
**CONFIDENTIAL**

REGRAIDING DATA CANNOT BE PREDETERMINED

**CONFIDENTIAL**

Test Program Request Nr. TE-20 (C) (Cont)

The following tools will be required for fuze setting:

- (1) Micrometer Depth Gage
- (2) Heavy screw driver
- (3) 1-1/8" open-end or adjustable wrench
- (4) Strap wrench or vise suitable to hold 155mm Shell body.

d. Fire ten Shell, T152E5, Comp A-3 Loaded, Lot PA-E-23880, and ten Shell, T152E6, Comp A-3 Loaded, Lot PA-E-23881, against the thickest plate defeated at 60° obliquity under phase c, at a range of 1000 yards and 60° obliquity.

Record muzzle velocity, facial impression dimensions and spall size for each shell. Calculate striking velocity for each shell. Recover and photograph spalls and back and front of target plate. Still photographs of shell striking target will be required, with camera at or near weapon position.

e. Composition A-3 Loaded shell of Lots PA-E-23880 and -23881 remaining after completion of phases c and d should be fired against an armored vehicle hull at an approximate range of 100 yards. A report of damage with photographs will be required. Still photographs of shell striking target will also be required, with camera at or near weapon position.

10. References:

- a. Letter, OCO to PA, ORDBB 471.14/975-139, 16 Sep 50.
- b. OCM-34159, 10 April 1952.
- c. Test Program Request Nr. 3672, dated 13 April 1953.

A-8  
**CONFIDENTIAL**

REGRAIDING DATA CANNOT BE PREDETERMINED

**CONFIDENTIAL**

Test Program Request Nr. TE-20 (C) (Cont)


11. Report Distribution:

a. Test Report security classification - Confidential.

- b. 1 Copy - OCO - ORDTA  
1 Copy - APG - ORDBG-DP-TA  
1 Copy - Chamberlain Corporation  
5 Copies - Picatinny Arsenal;

1 Copy - ATTN: Inspection Division  
1 Copy - ATTN: ORDBB-TE5  
1 Copy - ATTN: ORDBB-TE8  
1 Copy - ATTN: Propellant & Explosive Lab  
1 Copy - ATTN: Fuze Development Lab

D. R. BEEMAN  
Acting Director  
Samuel Feltman Ammunition Labs

  
J. E. RAINIER  
Assistant

A-9

**CONFIDENTIAL**

REGRAIDING DATA CANNOT BE PREDETERMINED

# CONFIDENTIAL

ARMY-P.A. DOVER, N.J. Woodhull **EXPERIMENTAL AMMUNITION DATA CARD** NO. 83332  
 ORDBB-43 7-28-58 800 2289

T.P.R. NO.	KIND				AMM. LOT NO.
SPEC. NO.	Shell, HEP-T, Inert Loaded, 155MM, T152E5 With Fuze, BD, M91A1 Inert Loaded With Live Tracer				PA-E-23878
DRG. NO.	DRG. DATE OR REV.	ALLOT. ADVICE	PROJECT NO.	RAD OR EPO NO.	QUANTITY IN LOT
None			T1A1-50024		48
P.A.X.O.	PROP. CHARGE	EXPECTED M.V.	EXPECTED PRESSURE	ASSEMBLED BY	DATE OF ASSEMBLY
629-176				PA	September, 1956

REMARKS: Packed: 1 Shell/wood box -saddle pack.

\*Filler Inert: 65% Borax, 30% K<sub>2</sub>SO<sub>4</sub>, 5% Graphite.

Shell ring gaged 100%. Empty weight of Shell 38.22 lbs. min., 38.63 lbs. max.  
 Weight of loaded and drilled shell 67.35 lbs min., 68.21 lbs Max., "As Fired" weight of Shell 70.10 min., 70.40 max.

COMPONENT	MPTS Assy	Fuze M91A1	*Filler		
KIND	155MM	BD, Inert	Inert		
	T152E5	With Live Tracer			
DRG. NO.	J7577-441	73-2-239		REGRAIDING DATA	CANNOT BE PREDETERMINED
DRG. DATE OR REV.	8-28-54	1-30-53			
MFG'D BY	Chamberlain	PA	PA		
DATE	1955	1956	1956		
LOT NO.	YCC-1153	PA-E-23981	None		

PREPARED BY F. Puccio

CERTIFIED TO BY: W. Knapp, INSPECTOR

Ars Opers

DIVISION

PICATINNY ARSENAL  
DOVER, NEW JERSEY

Inspection

DIVISION

ARMY-P.A. DOVER, N.J. Woodhull **EXPERIMENTAL AMMUNITION DATA CARD** NO. 83333  
 ORDBB-43 10-10-58 100 2289

T.P.R. NO.	KIND				AMM. LOT NO.
SPEC. NO.	Shell, HEP-T, Inert Loaded, 155MM, T152E6 With Fuze, BD, M91A1 Inert Loaded With Live Tracer				PA-E-23879
DRG. NO.	DRG. DATE OR REV.	ALLOT. ADVICE	PROJECT NO.	RAD OR EPO NO.	QUANTITY IN LOT
None			T1A1-5002H		20
P.A.X.O.	PROP. CHARGE	EXPECTED M.V.	EXPECTED PRESSURE	ASSEMBLED BY	DATE OF ASSEMBLY
629-176				PA	September, 1956

REMARKS: Packed: 1 Shell/wood box - saddle pack.

\*Filler Inert: 65% Borax, 30% K<sub>2</sub>SO<sub>4</sub>, 5% Graphite. Shell ring gaged 100%. Empty wt of shell 47.92 lbs min, 48.45 lbs max. Wt of loaded and drilled shell 71.02 lbs min, 72.86 lbs max.  
 "As fired" wt of shell 76.21 lbs min, 76.56 lbs max.

COMPONENT	MPTS Assy	Fuze BD	*Filler		
KIND	155MM	M91A1 Inert	Inert		
	T152E6	With Live Tracer			
DRG. NO.	J7577-599	73-2-239			
DRG. DATE OR REV.	6-1-55	1-30-53			
MFG'D BY	Chamberlain	PA	PA		
DATE	1955	1956	1956		
LOT NO.	YCC-1307	PA-E-23981	none		

PREPARED BY F. Puccio

CERTIFIED TO BY: W. Kishpaugh, INSPECTOR

Ars Opers

DIVISION

PICATINNY ARSENAL  
DOVER, NEW JERSEY

Inspection

DIVISION

A-10

# CONFIDENTIAL

# CONFIDENTIAL

ARMY-P.A. DOVER, N.J.  
ORDERS-43 10-10-55 100

Woodhull  
2269

## EXPERIMENTAL AMMUNITION DATA CARD

Shell 4' ordg 471/46 1957

T.P.R. NO.	KIND	PROJECT NO.			NO. 83334
SPEC. NO.	Shell, HEP, Comp A-3 Loaded, 155MM T152E5 with Fuze BD, T-Adjustable	TAL-5002H			AMM. LOT NO. PA-E-23880
DRG. NO.	DRG. DATE OR REV.	ALLOT. ADVICE	RAD OR EPO NO.	QUANTITY IN LOT 48	
None				QUANTITY IN SHIPMENT	
P.A.X.O.	PROP. CHARGE	EXPECTED M.V.	EXPECTED PRESSURE	ASSEMBLED BY PA	DATE OF ASSEMBLY September 1956
629-176					

REMARKS: Packed: 1 Shell/wood box, saddle pack.  
Empty wt of shell 8.12 lbs min, 8.67 lbs max. Wt of charge 35.77 lbs min, 36.11 lbs max.  
Avg specific gravity of charge 1.607 loaded wt. "As Fired" 67.7 lbs min, 70.4 lbs max.  
Shell press loaded using 1 tons (8000 PSI). Shell x-rayed and ring gaged 100%,  
Adjustable fuze set so perc plg travel is .210 (Firing pin to Detonator).

COMPONENT	MPTS Assy	Fuze BD	Filler			
KIND	155MM T152E5	T-Adjustable	Comp. A-3 Spec			
DRG. NO.	J7577-441	P-87758	JAN-C-440			
DRG. DATE OR REV.	8-28-54	9-12-55	1-31-47			
MFG'D BY	Chamberlain	PA	Wabash Ord			
DATE	1955	1956	1954			
LOT NO.	YCC-1153	PA-E-23909	WAB-13-411			

PREPARED BY F. Puccio

CERTIFIED TO BY:

W. Kishpaugh INSPECTOR

Ars Opers

PICATINNY ARSENAL  
DOVER, NEW JERSEY

Inspection

DIVISION

ARMY-P.A. DOVER, N.J.  
ORDERS-43 10-10-55 100

Woodhull  
2269

## EXPERIMENTAL AMMUNITION DATA CARD

Shell 5' ordg 471/46 1957

T.P.R. NO.	KIND	PROJECT NO.			NO. 83335
SPEC. NO.	Shell, HEP, Comp. A-3, Loaded, 155MM, T152E6 With Fuze BD, T-Adjustable	TAL-5002H			AMM. LOT NO. PA-E-23881
DRG. NO.	DRG. DATE OR REV.	ALLOT. ADVICE	RAD OR EPO NO.	QUANTITY IN LOT 42	
None				QUANTITY IN SHIPMENT	
P.A.X.O.	PROP. CHARGE	EXPECTED M.V.	EXPECTED PRESSURE	ASSEMBLED BY PA	DATE OF ASSEMBLY September, 1956
629-176					

REMARKS: Packed: 1 Shell/wood box. Saddle pack.  
Empty wt of shell 12.18 lbs min, 12.57 lbs max. Wt of charge 23.63 lbs min, 24.37 lbs max.  
Avg specific gravity of charge 1.65 .30mm loaded wt "As fired" 77.03 lbs min, 78.29 lbs max.  
Shell press loaded using 1 tons (8000 psi). Shell x-rayed and ring gaged 100%.  
Adjustable fuze set so Perc Plg Travel is .210 (Firing Pin to Detonator).

COMPONENT	MPTS Assy	Fuze BD	Filler			
KIND	155MM T152E6	T-Adjustable	Comp A-3 Spec			
DRG. NO.	J7577-599	P-87758	JAN-C-440			
DRG. DATE OR REV.	6-1-55	9-12-55	1-31-47			
MFG'D BY	Chamberlain	PA	Wabash Ord			
DATE	1955	1956	1954			
LOT NO.	YCC-1307	PA-E-23909	WAB-13-411			

PREPARED BY F. Puccio

CERTIFIED TO BY:

W. Kishpaugh INSPECTOR

Ars Opers

PICATINNY ARSENAL  
DOVER, NEW JERSEY

Inspection

DIVISION

A-11

# CONFIDENTIAL

ORDNANCE CORPS  
PICATINNY ARSENAL  
DOVER, NEW JERSEY

ACCOMMOD A

Mr. T. Clifford/bjb/2269

IN REPLY  
REFER TO:  
SAMUEL FELTMAN AMMUNITION LABORATORIES  
ORDNANCE

FILE

SUBJECT: TPR TE-20, Shell, 155 mm, HEP, ~~TL52E5~~ and -E6

TO: Commanding General  
Aberdeen Proving Ground  
Aberdeen, Maryland  
ATTENTION: ORDBG-DP-TA (Mr. H. Anderson)

The following data, pertaining to the subject TPR, are  
inclosed for your information and files:

a. Lists of shell weights for Ammunition Lot  
Numbers PA-E-23878, 23879, 23880 and 23881 (7 sheets).  
NOTE: Column marked "Complete Weight" is that of shell  
as fired.

b. Ammunition Data Cards Numbers 84429 and  
84430, in triplicate, pertaining to propelling charges for  
the subject TPR.

FOR THE COMMANDER:

J. E. RAINIER  
Assistant

*J. E. Rainier*

6 Incls  
1-4 List of shell weights  
for Lots PA-E-23878,  
23879, 23880, 23881  
5-6 Ammunition Data Cards  
Numbers 84429, 84430  
(in trip)

Sept 1956  
XO-629-176  
Lot PA-E-23878

SHEET 1 of 2

Shell, HEP-T, inert-loaded, 155mm,  
T152E5 with Fuze, BD, M91A1, inert-loaded

<u>SHELL NO</u>	<u>EMPTY WT</u>	<u>WT AFTER DRILLING</u>	<u>COMPLETE WT</u>
1	38.50 lbs	64.88 lbs	70.53 lbs
2	38.52	64.85	70.52
3	38.35	64.53	70.20
4	38.34	64.35	70.10
5	38.59	64.90	70.59
6	38.46	65.12	70.80
7	38.47	64.90	70.60
8	38.38	64.91	70.57
9	38.41	64.84	70.60
10	38.60	64.97	70.67
11	38.52	65.16	70.80
12	38.63	65.03	70.73
13	38.49	64.85	70.56
14	38.58	65.22	70.90
15	38.62	65.09	70.81
16	38.38	64.62	70.30
17	38.58	64.64	70.33
18	38.55	65.01	70.72
19	38.42	64.90	70.52
20	38.56	65.16	70.80
21	38.44	64.90	70.62
22	38.32	64.94	70.70
23	38.32	64.79	70.45
24	38.55	64.96	70.72
25	38.33	64.75	70.65
26	38.44	65.04	70.40
27	38.58	65.10	70.77
28	38.43	64.96	70.45
29	38.57	65.15	70.85
30	38.54	65.03	70.82
31	38.52	65.02	70.67
32	38.61	65.07	70.75
34	38.60	64.87	70.58
35	38.43	64.71	70.44
36	38.44	64.90	70.63
37	38.37	64.80	70.58
38	38.52	64.98	70.71
39	38.45	64.88	70.58
40	38.47	64.76	70.47
41	38.45	65.07	70.70
42	38.43	64.81	70.49

Lot PA-E-23878

SHEET 2 of 2

<u>SHELL NO</u>	<u>EMPTY WT</u>	<u>WT AFTER DRILLING</u>	<u>COMPLETE WT</u>
43	38.50	65.02	70.69
44	38.45	64.79	70.54
45	38.48	64.80	70.55
46	38.60	64.89	70.60
47	38.60	64.93	70.59
48	38.46	64.97	70.90
49	38.45	64.90	70.52

XO-629-176

Shell HEP inert-loaded 155mm, T152E6  
with Fuze BD, M91A1 inert-loaded with live Tracer  
Lot PA-E-23879

<u>SHELL NO</u>	<u>EMPTY WT</u>	<u>LOADED WT</u>	<u>COMPLETE WT</u>
1	47.56	72.02	77.70
35	47.82	72.11	77.87
55	47.02	71.35	77.07
19	47.83	72.24	77.97
46	47.10	71.46	77.17
2	48.45	72.86	78.55
43	47.94	72.24	77.85
60	47.05	71.33	77.10
5	48.23	72.53	78.32
7	48.32	72.80	78.56
57	47.48	71.71	77.38
34	48.01	72.42	78.22
30	48.12	72.50	78.33
4	48.24	72.43	78.18
62	48.08	72.45	78.08
40	48.28	72.54	78.31
52	46.79	71.02	76.77
8	48.40	72.72	78.49
49	48.11	72.42	78.21
61	47.29	71.66	77.50

Sept 1956  
XO-629-176  
Lot PA-E-23880

SHEET 1 of 2

Shell, HEP, Comp A3 loaded, 155mm, T152E5  
with Fuze BD, T - Adjustable

SHELL NO	EMPTY WT	EMPTY SHELL WITH WATER WT	WT AFTER DRILLING	WT AFTER DRILLING WITH WATER	WT OF CHARGE	COMPLETE WT	DENS
1	38.57		64.35		25.78	70.28	
2	38.25	55.28	64.07	65.14	25.82	69.99	1.617
3	38.64	55.68	64.45	65.68	25.81	70.37	1.632
4	38.53		64.55		26.02	70.25	
5	38.53		64.40		25.87	70.35	
6	38.59		64.37		25.78	70.25	
7	38.54		64.61		26.07	70.32	
8	38.46		64.47		26.01	70.15	
9	38.55		64.41		25.86	70.29	
10	38.10	55.21	63.93	64.99	25.83	69.78	1.609
11	38.36	55.41	64.37	65.46	26.01	70.03	1.629
12	38.46	55.46	64.49	65.60	26.03	70.16	1.638
13	38.41		64.19		25.78	70.21	
14	38.37		64.19		25.82	70.10	
15	38.35		64.35		26.00	70.08	
16	38.59		64.48		25.89	70.44	
17	38.50		64.48		25.98	70.13	
18	38.43		64.30		25.87	70.18	
19	38.41		64.34		25.93	70.16	
20	38.50		64.39		25.89	70.28	
21	38.49		64.32		25.83	70.14	
22	38.46		64.32		25.86	70.22	
23	38.23	55.33	64.00	65.05	26.77	69.86	1.605
24	38.51	55.60	64.59	65.69	26.08	70.26	1.631
25	38.40	55.47	64.40	65.50	26.00	70.15	1.629
26	38.54		64.65		26.11	70.29	
27	38.45		64.15		25.70	70.06	
28	38.26		64.14		25.88	70.03	
29	38.49		64.21		25.72	70.07	
30	38.49		64.20		25.71	70.00	
31	38.56		64.36		25.80	70.28	
32	38.51		64.27		25.76	70.15	
33	38.55		64.26		25.71	70.12	
34	38.31		64.05		25.74	70.00	
35	38.42		64.21		25.79	70.32	
36	38.55		64.27		25.72	70.19	
37	38.62	55.65	64.40	65.46	25.78	70.12	1.614
38	38.51		64.24		25.73	70.17	
39	38.48		64.20		25.72	70.10	
40	38.53		64.36		25.83	70.26	

Lot PA-E-23880

<u>SHELL NO</u>	<u>EMPTY WT</u>	<u>EMPTY SHELL WITH WATER WT</u>	<u>WT AFTER DRILLING</u>	<u>WT AFTER DRILLING WITH WATER</u>	<u>WT OF CHARGE</u>	<u>COMPLETE WT</u>	<u>DENS</u>
41	38.41		64.27		25.86	70.16	
42	38.49		64.23		25.74	70.06	
43	38.56		64.27		25.73	70.22	
44	38.59	55.57	64.60	65.73	26.01	70.32	1.641
45	38.56		64.31		25.75	70.20	
46	38.46		64.26		25.80	70.12	
47	38.42		64.12		25.70	70.04	
48	38.30		64.05		25.75	70.00	

Sept 1956  
XO-629-176  
Lot PA-E-23881

SHEET 1 of 1

Shell, HEP, Comp A3 loaded, 155mm,  
T152E6 with Fuze, BD, T - Adjustable

SHELL NO	EMPTY WT	EMPTY SHELL WITH WATER	WT AFTER DRILLING	WT AFTER DRILLING WITH WATER	WT OF CHARGE	COMPLETE WT	DENS
3	47.97		71.69		23.72	77.55	
6	48.25		72.15		23.90	77.84	
9	48.57	64.42	72.53	73.40	23.96	78.23	1.600
10	47.97		71.81		23.84	77.71	
11	48.48	64.15	72.15	73.13	23.75	78.12	1.607
12	48.22		72.01		23.79	77.92	
13	47.93		71.56		23.63	77.62	
14	47.93		71.86		23.93	77.62	
15	47.72		71.82		24.10	77.69	
16	48.30		72.25		23.95	77.97	
17	48.24		72.13		23.89	77.79	
18	48.13		72.19		24.06	77.92	
20	48.09		71.92		23.83	77.71	
21	48.30		72.08		23.78	77.91	
22	47.28	63.12	71.67	72.76	24.39	77.06	1.65
23	48.25		72.20		23.95	77.93	
24	48.07		71.88		23.81	77.82	
25	48.14		71.85		23.71	77.82	
26	48.29		72.05		23.76	78.00	
27	48.25		71.90		23.65	77.89	
28	47.80		71.80		24.00	77.54	
29	48.18		72.15		23.97	77.95	
31	48.24		71.97		23.73	77.87	
32	48.09		72.02		23.93	77.78	
33	48.37	64.12	72.15	73.19	23.78	78.28	1.61
36	48.12		72.09		23.97	77.91	
37	48.00		71.65		23.65	77.73	
38	48.06		71.88		23.82	77.55	
39	48.12		72.05		23.93	77.75	
41	48.31		72.23		23.92	77.96	
42	47.97		71.68		23.71	77.68	
44	48.23		72.20		23.97	77.97	
45	48.12		72.18		24.06	77.84	
47	47.83		71.70		23.87	77.48	
48	47.94		71.72		23.78	77.63	
50	47.29	63.09	71.63	72.72	24.34	77.02	1.65
51	48.07		71.81		23.74	77.65	
53	47.75		71.60		23.85	77.29	
54	47.98		71.90		23.92	77.62	
56	47.39	63.18	71.23	72.31	23.84	77.02	1.62
58	47.78		71.74		23.96	77.59	
59	48.25		72.15		23.90	77.84	

ARMY-P.A. DOVER, N.J. Baumann 5184 **EXPERIMENTAL AMMUNITION DATA CARD** NO. 84429  
ORDS-43 7-28-55 500

T.P.R. NO.	KIND				AMM. LOT NO.
SPEC. NO.	Charge, Propelling, T- For 155MM Howitzer, Projectile HEP-T152E6				PA-E-24684
DRG. NO.	DRG. DATE OR REV.	ALLOT. ADVICE	PROJECT NO.	RAD OR EPO NO.	QUANTITY IN LOT
P.A.X.O.	PROP. CHARGE	EXPECTED M.V.	EXPECTED PRESSURE	ASSEMBLED BY	DATE OF ASSEMBLY
629-176	9 lbs 15 ozs		TAL-5002H	PA	53 January, 1957

REMARKS: Packed: Improvised, in M10A1 Cartridge storage case.  
Igniter Pads fabricated in accordance with Dwg's 71-9-180, Rev. 3-19-45, Dwg. 71-9-181, Rev. 10-25-51 and Dwg. 71-9-182, Rev. 3-19-45.  
Charge Bag, dimensions: 5 1/4" diameter, 15" long. Charge weight each 9 lbs. 15 ozs.

COMPONENT	Cloth Silk	Cloth Silk	Propellant	Black			
KIND	Ctg Bag	Ctg. Bag	MI	Powder			
	Class "E"	Class "C"		Gr. A1			
DRG. NO.							
DRG. DATE OR REV.							
MFG'D BY	Susquehanna	Unk	Indiana	King Pwd Depot			
DATE	Unk	Unk	1943	12-8-53			
LOT NO.	SMI-15	Unk	IND-6667	KPD-1-61			

PREPARED BY L. Koza CERTIFIED TO BY: F. Holloway INSPECTOR  
Ars Opers DIVISION PICATINNY ARSENAL 454 Inspection DIVISION  
DOVER, NEW JERSEY

ARMY-P.A. DOVER, N.J. Baumann 5184 **EXPERIMENTAL AMMUNITION DATA CARD** NO. 84430  
ORDS-43 7-28-55 500

T.P.R. NO.	KIND				AMM. LOT NO.
SPEC. NO.	Charge, Propelling T- For 155MM Howitzer, Projectile, HEP, T152E5				PA-E-24685
DRG. NO.	DRG. DATE OR REV.	ALLOT. ADVICE	PROJECT NO.	RAD OR EPO NO.	QUANTITY IN LOT
P.A.X.O.	PROP. CHARGE	EXPECTED M.V.	EXPECTED PRESSURE	ASSEMBLED BY	DATE OF ASSEMBLY
629-176	9 lbs 5 ozs.		TAL-5002H	PA	82 January, 1957

REMARKS: Packed: Improvised, in M10A1 Cartridge storage case.  
Igniter pads fabricated in accordance with Dwg's 71-9-180, Rev. 3-19-45, Dwg. 71-9-181, Rev. 10-25-51 and Dwg. 71-9-182, Rev. 3-19-45.  
Charge Bag dimensions: 5 1/4" diameter, 14" long. Charge weight each 9 lbs. 5 ozs.

COMPONENT	Cloth Silk	Cloth Silk	Propellant	Black			
KIND	Ctg Bag	Ctg. Bag	MI	Powder			
	Class "E"	Class "C"		Gr. A-1			
DRG. NO.							
DRG. DATE OR REV.							
MFG'D BY	Susquehanna	Unk	DuPont	King Pwd Depot			
DATE	Unk	Unk	1941	12-8-53			
LOT NO.	SMI-15	Unk	CPX-4394	KPD-1-61			

PREPARED BY L. Koza CERTIFIED TO BY: F. Holloway INSPECTOR  
Ars Opers DIVISION PICATINNY ARSENAL 454 Inspection DIVISION  
DOVER, NEW JERSEY A-18

JOINT MESSAGEFORM				SECURITY CLASSIFICATION UNCLASSIFIED	
SPACE BELOW RESERVED FOR COMMUNICATION CENTER					
PRECEDENCE		TYPE MSG (Check)		ACCOUNTING SYMBOL	ORIG. OR REFERS TO
ACTION <b>MAIL</b>	BOOK	MULTI	SINGLE		CLASSIFICATION OR REFERENCE
INFO			X		
<b>FROM:</b> CO PICATINNY ARSENAL DOVER NJ					<b>SPECIAL INSTRUCTIONS</b>  <div style="text-align: center; font-size: 2em; transform: rotate(-90deg);">617/16.4 7/70</div>
<b>TO:</b> COMMANDING GENERAL ABERDEEN PROVING GROUND MARYLAND ATTN: ORDBG-DPS-AA (MR. ALLEN)					
<b>INFO:</b> CHAMBERLAIN CORP., 100 MILDRED ST., WATERLOO, IOWA ATTENTION: MR. I. HERMAN (MAIL)					
<p>1. IT IS REQUESTED THAT TEST PROGRAM REQUEST NO. TE-20 BE AMENDED AS FOLLOWS:</p> <p style="margin-left: 40px;">A. CONDUCT COMPARATIVE PANEL FRAGMENTATION TESTS OF TWO EACH T152E5 AND T152E6, 155 MM SHELL WITH TWO M107 STANDARD HE SHELL.</p> <p style="margin-left: 40px;">B. THE REMAINING T152 SHELL (TWELVE -E5 AND EIGHT -E6) SHOULD BE FIRED FROM THE M1 HOWITZER FOR COMPARATIVE MAXIMUM RANGE AND DISPERSION WITH TEN M107 STANDARD HE SHELL.</p> <p style="margin-left: 40px;">C. COMPLETE PHOTOGRAPHIC COVERAGE, INCLUDING SOUND OF FIRING AND SHELL DETONATION, IS REQUIRED, ALSO, COMPLETE CHEMICAL ANALYSIS AND MECHANICAL PROPERTIES OF KING TIGER TANK FACE PLATE.</p>					
<b>SYMBOL</b> ORDBB-TE5 <span style="float: right;">A-19</span>					<b>DATE</b> MAY 15 57-4 PM
<b>TYPED NAME AND TITLE (Signature, if required)</b> Mr. T. Clifford/sjm					<b>MONTH</b> 
<b>PHONE</b> 2269					<b>YEAR</b> 
<b>PAGE NR.</b> 1					<b>NR. OF PAGES</b> 2

DD

FORM 173

REPLACES DD FORM 173 1 OCT 49,  
WHICH IS OBSOLETE FOR ARMY USE.

A-20

☆ U. S. GOVERNMENT PRINTING OFFICE: 1957-O-347884

**CONFIDENTIAL**

**DEVELOPMENT AND PROOF SERVICES  
ABERDEEN PROVING GROUND, MARYLAND  
FIRING RECORD**

APPENDIX B

OBJECT OF TEST: Accuracy and Armor Defeating      DATES OF TEST: 27 Mar thru  
Evaluation of Shell, HEP, 155mm,      25 Jun 1957  
T152E5 and T152E6      FIRING RECORD NO.: P-62648  
SHEET 1 OF 6  
AUTHORITY: ORDBG-TE5  
c) 471/46, TPR No. TE-20  
MESSAGEFORM ORDBG, 471/417  
W.O. NO.: 332-236-54      eh

DEVELOPMENT: ORDTA  
PROJECT NO.: TAL-5002H  
PRIORITY: 1B

MATERIEL

For Accuracy and Plate Firing

Howitzer: 155mm, M1, No. 7.  
Carriage: 155mm, M1A1, No. 497.  
Recoil Mechanism: 155mm, M6, No. 3089.

For Range Firing

Howitzer: 155mm, M1, No. 2199.  
Carriage: 155mm, M1A1, No. 497.  
Recoil Mechanism: 155mm, M6, No. 3089.

AMMUNITION COMPONENTS

1. Shell, HEP-T, Inert-Loaded, 155mm, T152E5, w/Fuze, BD, M91A1, Inert-Loaded, w/Live Tracer, Lot No. PA-E-23878.
2. Shell, HEP-T, Inert-Loaded, 155mm, T152E6, w/Fuze, BD, M91A1, Inert-Loaded, w/Live Tracer, Lot No. PA-E-23879.
3. Shell, HEP, Comp A-3-Loaded, 155mm, T152E5, w/Fuze, BD, T-Adjustable, Lot No. PA-E-23880.
4. Shell, HEP, Comp A-3-Loaded, 155mm, T152E6, w/Fuze, BD, T-Adjustable, Lot PA-E-23881.
5. Shell, HE, TNT-Loaded, M107, w/supplementary charge, w/Fuze, PD, M51A5, Lot No. WC-31-82.
6. Charge, Propelling, T-, for 155mm Howitzer, Projectile, HEP, T152E5, Lot No. PA-E-24685.
7. Charge, Propelling, T-, for 155mm Howitzer, Projectile, HEP, T152E6, Lot No. PA-E-24684.
8. Charge, Propelling, M4A1, for 155mm Howitzer, Projectile, HE, M107, Lot No. RAD-19612-45.
9. Primer, Percussion, Mk2A4, 19 grains, Lot No. PA-6-47.

COIL DISTANCES

<u>ROUNDS</u>	<u>26 March</u>	
1-4	Muzzle to 1st Coil	49.32 feet
	Between Coils	75.0 feet

B-1

**CONFIDENTIAL**

# CONFIDENTIAL

FIRING RECORD NO. P-62648  
SHEET 2 OF 6

<u>ROUNDS</u>		<u>COIL DISTANCES (Contd.)</u>	
5-8	Muzzle to 1st Coil		51.0 feet
	Between Coils		73.24 feet
<u>27 March</u>			
All rounds	Muzzle to 1st Coil		53.25 feet
	Between Coils		72.0 feet
<u>28 March</u>			
1-4	Muzzle to 1st Coil		54.30 feet
	Between Coils		70.50 feet
5 & 6	Muzzle to 1st Coil		54.41 feet
	Between Coils		70.90 feet
7-14	Muzzle to 1st Coil		54.32 feet
	Between Coils		76.1 feet
15-17	Muzzle to 1st Coil		54.76 feet
	Between Coils		70.20 feet
<u>10 April</u>			
All rounds	Muzzle to 1st Coil		53.7 feet
	Between Coils		60.34 feet
<u>11 April</u>			
All rounds	Muzzle to 1st Coil		50.57 feet
	Between Coils		60.8 feet
<u>27 April</u>			
All rounds	Muzzle to 1st Coil		51.4 feet
	Between Coils		48.96 feet
<u>4 May</u>			
All rounds	Muzzle to 1st Coil		49.47 feet
	Between Coils		50.04 feet
<u>25 June</u>			
All rounds	Muzzle to 1st Coil		79.28 feet
	Between Coils		29.98 feet

## PRESSURE GAGE DESCRIPTION

Type of Gage: Medium Caliber (M3) Copper Cup  
Crusher Cylinder: Copper metal of 1955, annealed 1956, Lot 7-C  
Position in Tube: One on each side of charge.

<u>ARMOR PLATE DATA</u>			
<u>PLATE NO.</u>	<u>8-INCH PLATE 120" X 120"</u>	<u>BRINELL</u>	
	<u>CHARPY @ -40°F.</u>	<u>TOP</u>	<u>BOTTOM</u>
070960	71.71	225	248
14073	62.00/81.00	241	241
<u>7-INCH PLATE 120" X 120"</u>			
14001-2	103.77/91.46	235	232
14063-1	57.00/34.00	229	229

CONFIDENTIAL

FIRING RECORD NO. P-66648  
SHEET 3 OF 6

ROUND-BY-ROUND DATA OF PLATE FIRING AT 400 FEET

DATE FIRING (1957)	TIME FIRING NO.	PROJECTILE		SPEEDING VELOCITY (FPS)	CHAMBER PRESSURE PSI/100	SPALL VELOCITY (FPS)	DIA. OF PLATE (in.)	DEGREE OF COLLUSION	TYPE OF SPALL	MEASUREMENT OF SPALL				TYPE OF PISTOL (CAL.)	TYPE OF PISTOL (CAL.)
		TEST NO.	TYPE							FRONT VERT.	DEPTH VERT.	FRONT HORIZ.	DEPTH HORIZ.		
26 Mar	4508	1	55	1815	277	1786	8	0	Complete	12 3/16	x 11	x 10 1/2	x 1 3/4	.20073	Not taken
	4509	2	55	1827	278	1790	8	0	Complete	12	x 12 3/4	x 13/16	x 1 3/4	.20073	Not taken
	4510	3	56	1850	319	1824	8	0	Complete	13	x 14	x 15/16	x 3/4	.20073	Not taken
	4511	4	56	1865	310	1836	8	0	Complete	13	x 14	x 15/16	x 3/4	.20073	Not taken
	4512	5	56	1865	321	1836	8	0	Complete	13	x 14	x 15/16	x 3/4	.20073	Not taken
	4513	6	56	1865	321	1836	8	0	Complete	13	x 14	x 15/16	x 3/4	.20073	Not taken
	4514	7	56	1865	321	1836	8	0	Complete	13	x 14	x 15/16	x 3/4	.20073	Not taken
	4515	8	56	1865	321	1836	8	0	Complete	13	x 14	x 15/16	x 3/4	.20073	Not taken
	4516	9	56	1865	321	1836	8	0	Complete	13	x 14	x 15/16	x 3/4	.20073	Not taken
	4517	10	56	1865	321	1836	8	0	Complete	13	x 14	x 15/16	x 3/4	.20073	Not taken
27 Mar	4518	1	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4519	2	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4520	3	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4521	4	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4522	5	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4523	6	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4524	7	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4525	8	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4526	9	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4527	10	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
28 Mar	4528	1	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4529	2	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4530	3	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4531	4	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4532	5	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4533	6	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4534	7	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4535	8	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4536	9	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken
	4537	10	55	1864	284	1797	8	0	Complete	13 1/4	x 14	x 1 9/16	x 1 3/4	.19552	Not taken

B-3

CONFIDENTIAL

**CONFIDENTIAL**

FIRING RECORD NO. P-62648  
SHEET 4 OF 6

**ACCURACY ROUND-BY-ROUND FIRING DATA**

ACCURACY ROUND-BY-ROUND FIRING DATA										TIME	
TUBE TEST		PROJECTILE			INSTRUMENT	CHAMBER	ELEVA-	TARGET MEAS.		OF	
RD.	RD.	RD.		WEIGHT	VELOCITY	PRESS.	TION	(in.)		FLIGHT	
NO.	NO.	NO.	TYPE	(lbs.)	(fps)	psi/100	mils	VERT.	HOR.	(sec.)	
10 April											
4549	34	*	A	E5	70.50	Not taken	291	32			
4550	11	*	B	E5	70.91	Not taken	294	28			
4551	44	*	C	E5	70.49	Not taken	293	26			
4552	36	*	D	E5	70.56	Not taken	293	24			
4553	31	*	E	E5	70.71	Not taken	296	22			
4554	1	*	F	E5	70.53	Not taken	293	18			
4555	39	*	G	E5	70.57	Not taken	287	18			
4556	7	1	E5	70.59	1804	282	18	+26 1/2	+21	1.80366	
4557	3	2	E5	70.20	1810	281	18	+26 1/2	+24	1.79962	
4558	48	3	E5	70.66	1805	284	18	-17 1/2	+31	1.80115	
4559	38	4	E5	70.69	1806	290	18	-27 1/2	+21	1.80276	
4560	4	5	E5	70.07	1812	285	18	+15	-9	1.79531	
4561	34	6	E5	70.57	1803	291	18	+26 1/2	+2	1.80983	
4562	32	7	E5	70.73	1806	289	18	+17 1/2	+4 1/2	1.80254	
4563	8	8	E5	70.59	1808	289	18	+23	+6	Lost	
4564	10	9	E5	70.68	1803	286	18	+18	+7 1/2	1.80988	
4565	27	10	E5	70.75	1809	290	18	+37 1/2	-12 1/2	1.80170	
4566	35	1	E5	70.45	1808	280	18	+27 1/2	-6 1/2	1.80223	
4567	9	2	E5	70.56	1809	288	18	+54	-36	1.80150	
4568	26	3	E5	70.45	1817	290	18	+22 1/2	-18	1.79374	
4569	19	4	E5	70.57	1817	303	18	+41 1/2	-27 1/2	1.79220	
4570	22	5	E5	70.66	1810	294	18	+35 1/2	-3 1/2	1.79830	
4571	49	6	E5	70.47	1812	291	18	+3 1/2	-45	1.79729	
4572	17	7	E5	70.34	1816	298	18	+16 1/2	-51	1.79370	
4573	40	8	E5	70.57	1808	286	18	+43 1/2	-42	1.80150	
4574	47	9	E5	70.56	1813	287	18	+27 1/4	-47	1.79880	
4575	20	10	E5	70.55	1811	287	18	+64	-35	1.79993	
4576	46	1	E6	77.16	1827	314	18	-49 1/2	-62 1/2	1.76341	
4577	49	2	E6	78.15	1819	315	18	-33 1/2	-12	1.77006	
4578	1	3	E6	77.71	1824	316	18	-40 1/2	+13	1.76532	
4579	62	4	E6	78.12	1826	318	18	-26	-3 1/2	1.76278	
4580	52	5	E6	76.80	1835	307	18	-41	-6 1/2	1.75500	
4581	30	6	E6	78.24	1821	316	18	-34	-50 1/2	1.76988	
4582	57	7	E6	77.37	1830	309	18	-33	-25	1.75801	
4583	5	8	E6	78.23	1821	308	18	-17	-17	1.76939	
4584	60	9	E6	77.06	1834	308	18	-28	-19 1/2	1.75622	
4585	34	10	E6	78.18	1817	316	18	-39	-32 1/2	1.77089	
4586	8	11	E6	78.44	1817	308	18	-38	-35	1.77285	
11 April											
4587	20	*	H	E5	70.83	1811	290	18	+17	+18 1/2	1.79972
4588	30	*	I	E5	70.74	1807	293	18	+2 1/2	0	1.80328
4589	24	1	E5	70.69	1810	294	18	+23	+2	1.79820	
4590	13	2	E5	70.79	1809	294	18	+11	+18	1.80071	
4591	46	3	E5	70.59	1807	294	18	+19 1/2	+9 1/2	1.80211	
4592	12	4	E5	70.48	1812	294	18	+17	+8	1.79637	
4593	45	5	E5	70.59	1805	286	18	-18	+13	1.80523	

\* Conditioning Rds.

B-4

**CONFIDENTIAL**

CONFIDENTIAL

FIRING RECORD NO. P-62648  
SHEET 5 OF 6

ROUND-BY-ROUND DATA OF PLATE FIRING 1000 YARDS

TUBE NO.	TEST RD.	PROJECTILE WEIGHT (lbs.)	VELOCITY (fps)	CHAMBER PRESSURE psi/100	DLA. OF PLATE (in.)	DEGREE OF OBLIQ- UITY	TYPE OF SPALL	MEASUREMENT OF SPALL			
								FRONT (in.)	REAR (in.)	VERT.	DEPTH
DATE FIRED	RD.	TYPE	INSTRU- MENT	SPALL	PAI/100	UTY	SPALL	VERT.	DEPTH	VERT.	DEPTH
27 Apr	4594	E5	1815	Missed plate	289	0	Complete	12	1 1/4	12	2 1/4
	4595	E5	1819	681	319	0	Complete	13	1 1/2	13	2 1/2
	4596	E5	1820	682	296	0	Complete	13	1	13	2 1/2
	4597	E5	1819	585	329	0	Complete	13	1	13	2 1/2
	4598	E5	1820	723	322	0	Complete	12	3/4	13	2 1/4
	4599	E5	1825	Low order	314	0	None	--	--	--	--
	4600	E5	1823	Fell short	300	0	--	--	--	--	--
	4601	E5	1823	Hit base of plate	305	0	--	--	--	--	--
	4602	E5	1823	Lost	303	0	Complete	13	3/4	13 1/2	1 3/4
	4603	E5	1820	644	298	0	Complete	13	3/4	13 1/4	1 3/4
	4604	E5	1824	985	299	0	Complete	12	3/4	13 1/2	1 3/4
	4605	E5	1821	Not taken	298	0	Complete	12	3/4	13 1/2	1 3/4
	4606	E5	1823	Not taken	291	44	Complete	14	1 1/4	12	14
	4607	E5	1810	Not taken	290	60	Missed plate	--	--	--	--
4 May	4608	E5	1818	Not taken	296	7	Complete	15	3/4	13	1 3/4
	4609	E5	1820	Not taken	301	7	Complete	16	3/4	16	2
	4610	E5	1818	Not taken	307	7	Hit base of turret	--	--	--	--
	4611	E5	1811	Not taken	303	7	Partial	15	3/4	8	1 3/4
	4612	E5	1815	Not taken	299	7	Complete	15	1/2	8	2 1/2
	4613	E5	1817	Not taken	302	7	Partial	15	3/4	8	2 1/2
	4614	E5	1823	Low order	301	7	None	15	3/4	340° cracked bulge	
	4615	E5	1818	Low order	298	60	None	--	--	--	--
	4616	E5	1823	Low order	295	7	Complete	15	3/4	12	10
	4617	E5	1812	Low order	301	7	Complete	15	3/4	11 1/2	10 1/2
	4618	E5	1824	Low order	303	7	None	13	3/4	9	10 1/2

Impacted between Rds. 3 & 7.  
10 2 8 3/4  
10 1/2 2 9  
Impacted between Rds. 6 & 8.

B 5

CONFIDENTIAL

**CONFIDENTIAL**

FIRING RECORD NO. P-62648  
SHEET 6 OF 6

MAXIMUM RANGE AND DISPERSION ROUND-BY-ROUND DATA - TUBE NO. 2199

TUBE RD. NO.	PROJECTILE		CHARGE LOT	PRESS. psi/100	MUZZLE VELOCITY (fps)	DEFLECTIONS		MEAS. RANGE yards	TIME OF FLIGHT (sec.)	ORDER OF DETO- NATION
	TYPE	WEIGHT (lbs.)				mils	yards			
1183	M107	95.1	M4A1	312	1839	21.9	344	16036	59.75	HO
1184	M107	95.1	M4A1	305	1836	22.4	349	15917	59.54	HO
1185	M107	95.1	M4A1	313	1835	21.9	342	15944	59.55	HO
1186	M107	95.1	M4A1	326	1843	20.6	321	15909	59.56	HO
1187	M107	95.1	M4A1	316	1842	21.0	329	15971	59.52	HO
1188	M107	95.1	M4A1	314	1842	21.5	333	15810	59.37	HO
1189	M107	95.1	M4A1	323	1827	21.9	341	15879	59.46	HO
1190	M107	95.1	M4A1	322	1842	22.6	352	15887	59.58	HO
1191	M107	95.1	M4A1	318	1836	22.7	354	15931	59.55	HO
1192	M107	95.1	M4A1	310	1825	21.2	330	15901	59.17	HO
1193	T152E5	71.0	PA-E-24685	326	1827	41.3	455	11252	52.38	HO
1194	T152E5	71.0	PA-E-24685	318	1829	40.0	446	11365	52.45	HO
1195	T152E5	71.0	PA-E-24685	314	1830	40.5	450	11338	52.18	HO
1196	T152E5	71.0	PA-E-24685	319	1826	41.3	459	11332	52.33	HO
1197	T152E5	71.0	PA-E-24685	324	1828	39.6	442	11400	52.11	HO
1198	T152E5	70.5	PA-E-24685	322	1826	40.3	447	11307	52.05	HO
1199	T152E5	71.0	PA-E-24685	323	1828	42.4	463	11150	52.12	HO
1200	T152E5	71.0	PA-E-24685	320	1825	41.6	463	11350	52.18	HO
1201	T152E5	71.0	PA-E-24685	304	1823	42.9	472	11223	52.19	HO
1202	T152E5	70.5	PA-E-24685	315	1827	42.5	465	11159	52.01	HO
1203	T152E5	71.0	PA-E-24685	314	1829	41.9	463	11277	52.21	HO
1204	T152E5	70.5	PA-E-24685	321	1835	36.7	413	11471	52.58	Failed
1205	T152E6	78.5	PA-E-24684	296	1834	41.0	476	11852	53.30	HO
1206	T152E6	78.5	PA-E-24684	313	1824	42.6	493	11818	53.10	HO
1207	T152E6	78.5	PA-E-24684	293	1831	42.4	490	11803	53.14	HO
1208	T152E6	78.5	PA-E-24684	299	1828	41.3	481	11873	53.13	HO
1209	T152E6	78.0	PA-E-24684	301	1829	42.2	489	11833	53.21	HO
1210	T152E6	78.0	PA-E-24684	302	1834	40.7	477	11969	53.20	HO
1211	T152E6	78.0	PA-E-24684	304	1835	44.3	514	11839	53.20	HO
1212	T152E6	78.5	PA-E-24684	307	1830	42.6	498	11931	53.30	HO

NOTE: Deflection measured to right of line of fire. Range measure from muzzle to point of impact. HO = High Order

This firing record forms a part of the Seventh Report on Ordnance Corps Project No. TA1-5002H.

APPROVED:

*H. A. Bechtol*  
H. A. BECHTOL  
Chief, Artillery  
Division

*H. B. Anderson*  
H. B. ANDERSON  
Chief, Artillery  
Ammunition Branch

*Ralph H. Allen*  
RALPH H. ALLEN  
Proof Director

CONFIDENTIAL



420Pn

CONFIDENTIAL

ABERDEEN PROVING GROUND

28 March 1957

Project No. TAL-5002H/TE20. Accuracy and Armor Defeating Evaluation of Shell, HEP, 155mm.

Open shutter photograph of Shell, HEP, 155mm, T152E6, striking 7 inch plate at 60 degrees obliquity.

CONFIDENTIAL



429Pn CONFIDENTIAL 8 ABERDEEN PROVING GROUND 8 28 March 1957

Project No. TA1-5002H/TE20. Accuracy and Armor Defeating Evaluation of Shell, HEP, 155mm.

Open shutter photograph of Shell, HEP, 155mm, T152E5, striking 7 inch plate at 60 degrees obliquity.

CONFIDENTIAL



B24568: Rear of 8 inch armor plate fired at 60 degrees obliquity, showing bulges. Bulges 1 and 2 were caused by T152E5 HEP Shell. Bulges 3 and 4 were caused by T152E6 HEP Shell. Distance from muzzle to plate center - 401.24 feet. Charpy value of plate - 62/81, Bhn 241.

C-3

CONFIDENTIAL

CONFIDENTIAL



B24567: Face of 8 inch armor plate at 60 degrees obliquity. Note cracks on edge of plate adjacent to Round 1 which extend to face of plate.

C-4

CONFIDENTIAL

CONFIDENTIAL



B24566: Photograph of Shell, HEP, 155mm, T152E5, with charge.

C-5  
CONFIDENTIAL

CONFIDENTIAL



B24565: Photograph of Shell, HEP, 155mm, T152E6, with charge.

C-6

CONFIDENTIAL

CONFIDENTIAL

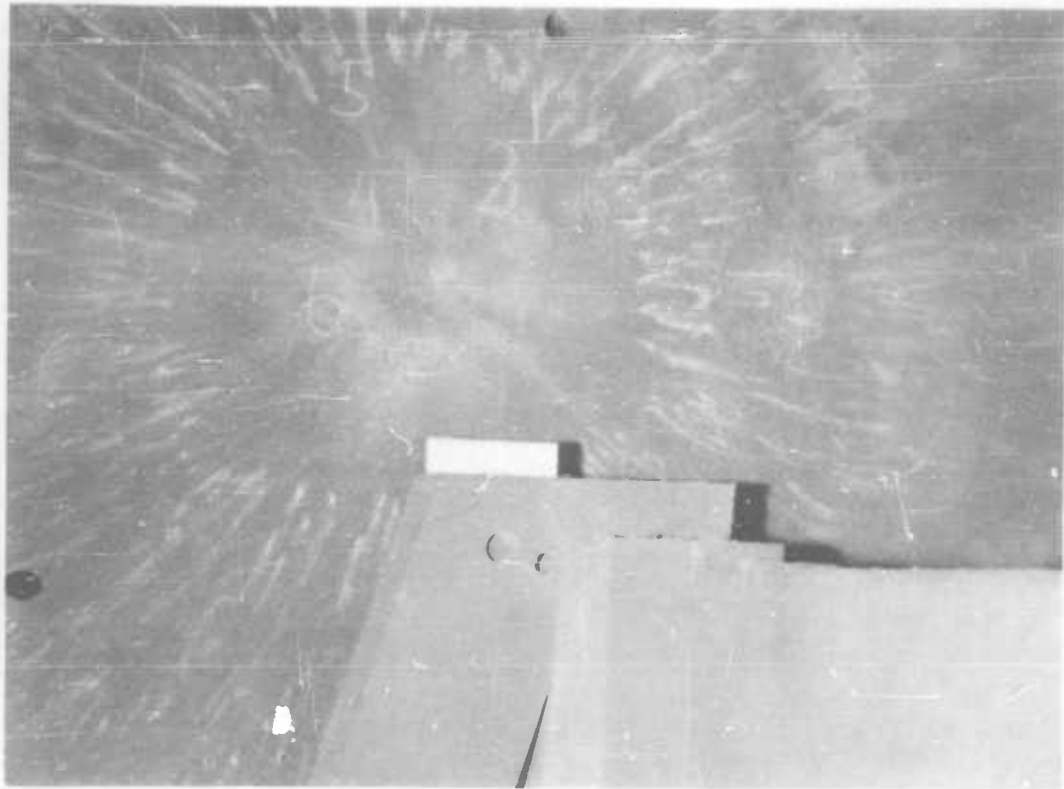


B24577: Side view of 8 inch plate at 0 degrees obliquity, showing depths of back spalls. Rounds 7 through 16. Note: back spall, Round 14, is a double spall.

C-7

CONFIDENTIAL

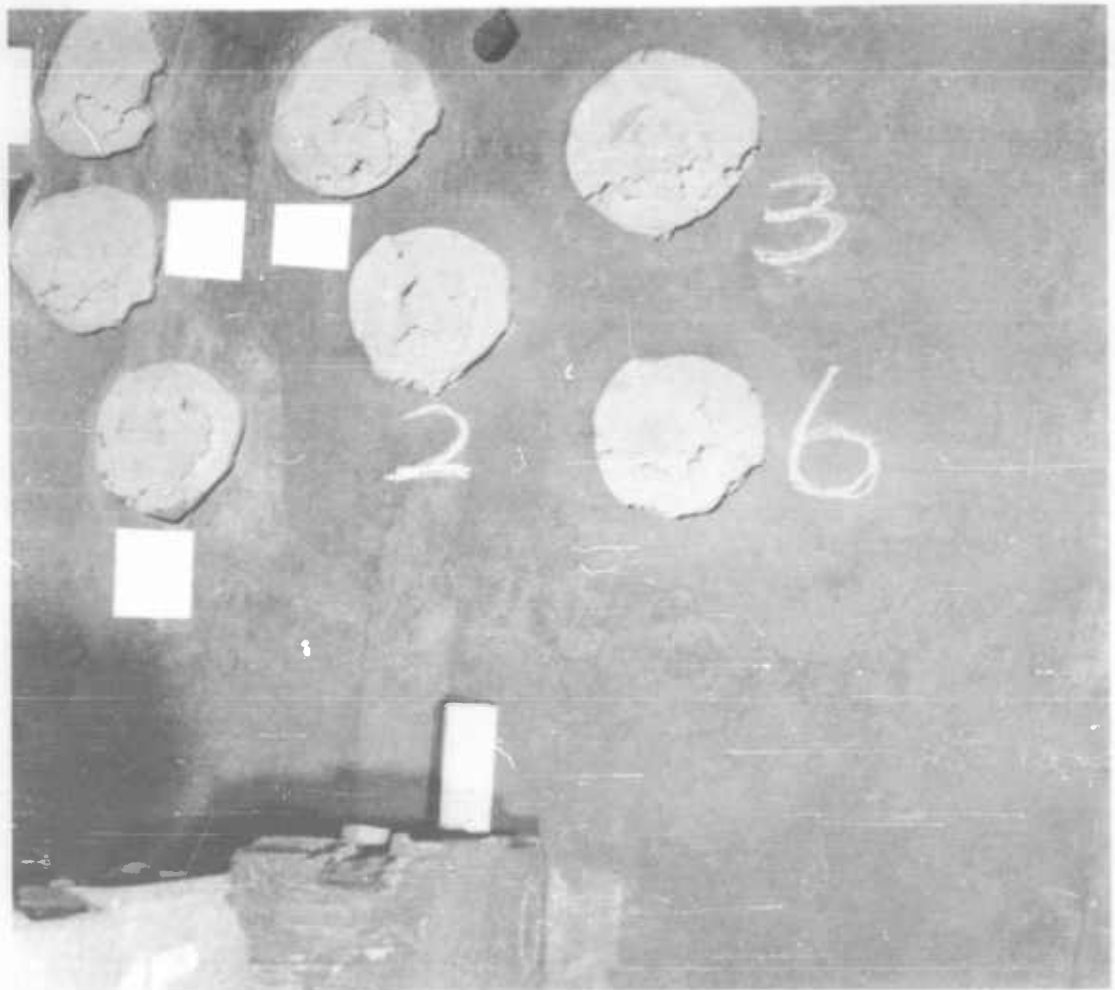
CONFIDENTIAL



324576: Front view of 8 inch plate fired at 0 degrees obliquity, showing hits. Rounds 1 through 6. Rounds 1, 3, and 4 failed to function and were low order due to bad fuzes.

C-8  
CONFIDENTIAL

CONFIDENTIAL

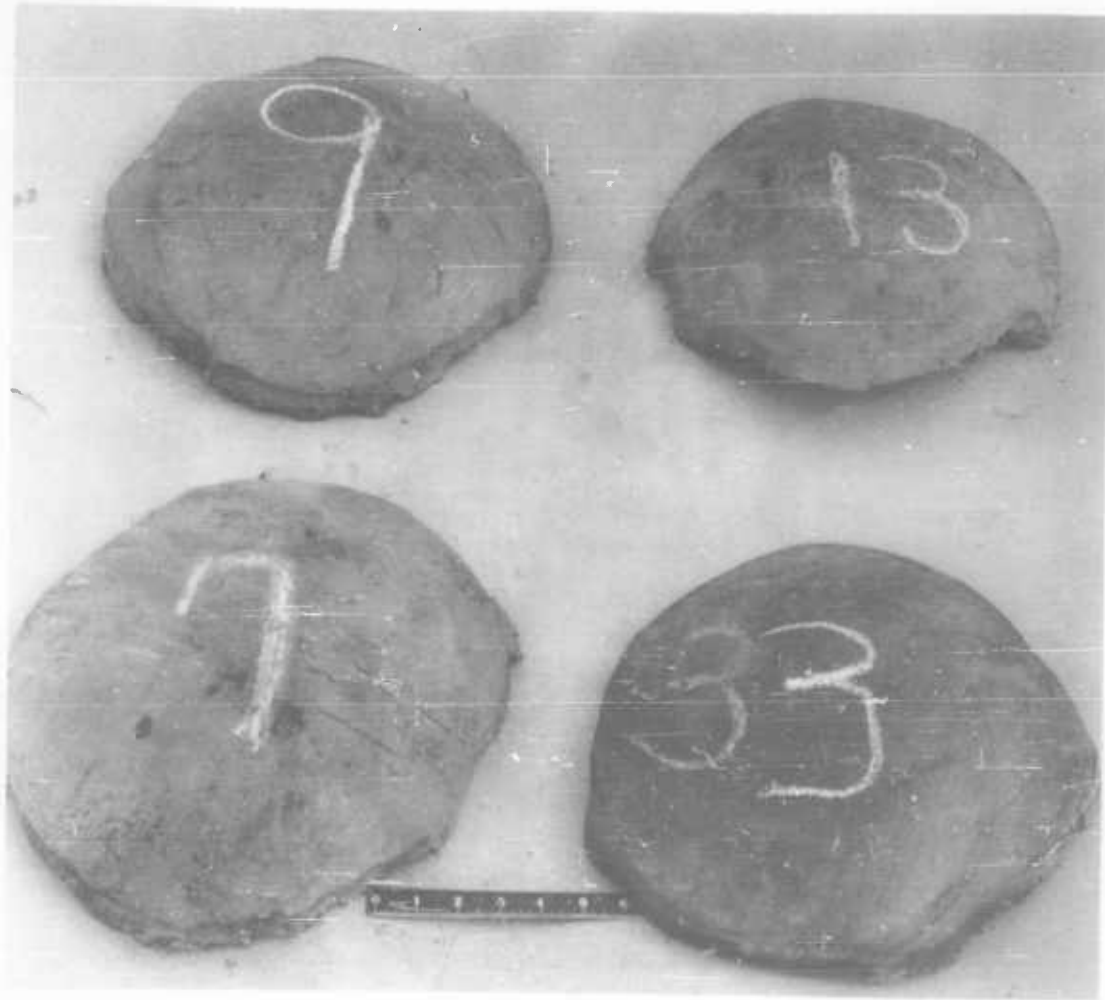


324575: Rear of 8 inch plate fired at 0 degrees obliquity, showing back spalls from Rounds 1 through 6. Rounds 1, 4, and 5 did not spall as fuze failed to function.

C-9

CONFIDENTIAL

CONFIDENTIAL



B24574: Front view of four back spalls. Weight of spalls - No. 3 - 48 lbs., No. 7 - 63 lbs., No. 9 - 38 lbs., No. 13 - 27 lbs. 8 inch plate fired at 0 degrees obliquity. Distance from muzzle to plate center - 401 feet.

C-10

CONFIDENTIAL

CONFIDENTIAL

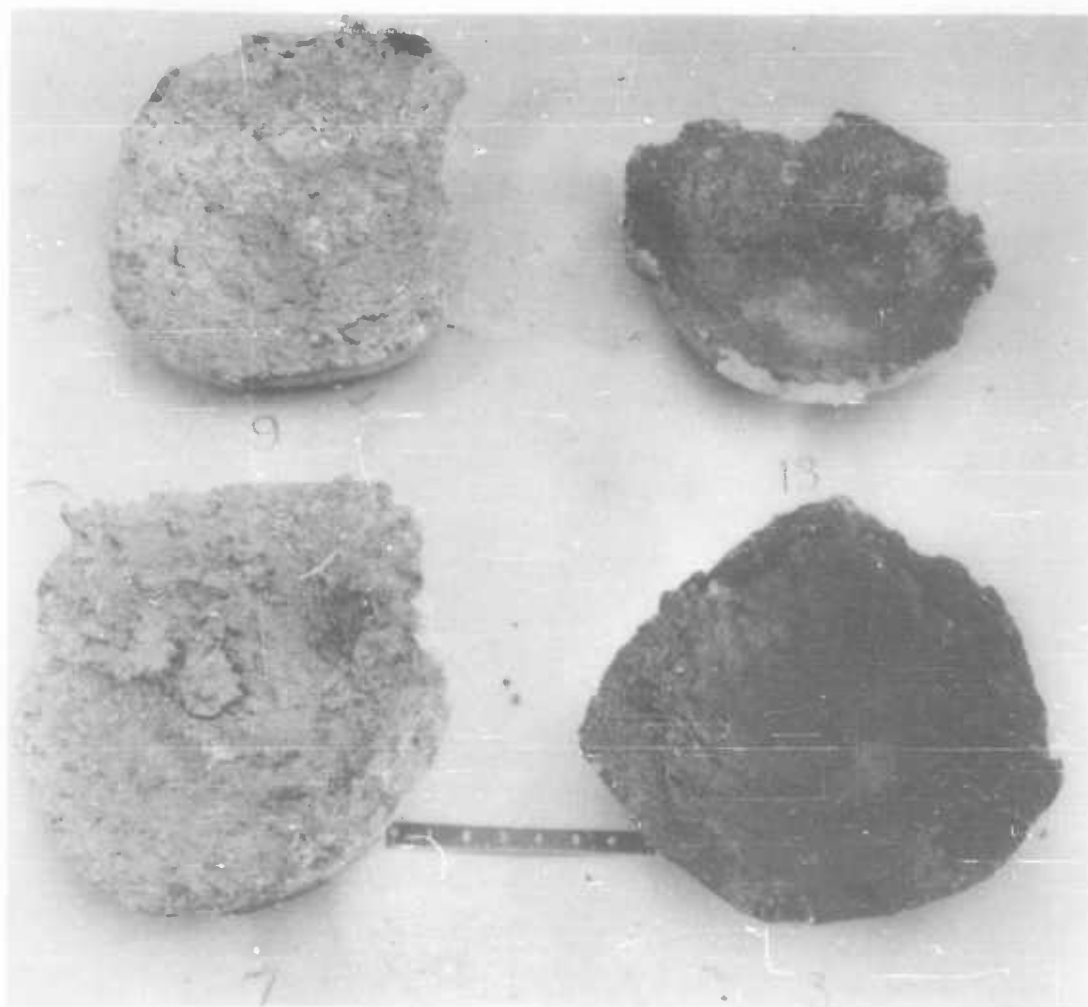


B24573: Front view of 8 inch plate fired at 0 degrees obliquity, showing hits. Rounds 7 through 16. The depth of impressions from the hits average  $\frac{3}{4}$  inch in depth.

C-11

CONFIDENTIAL

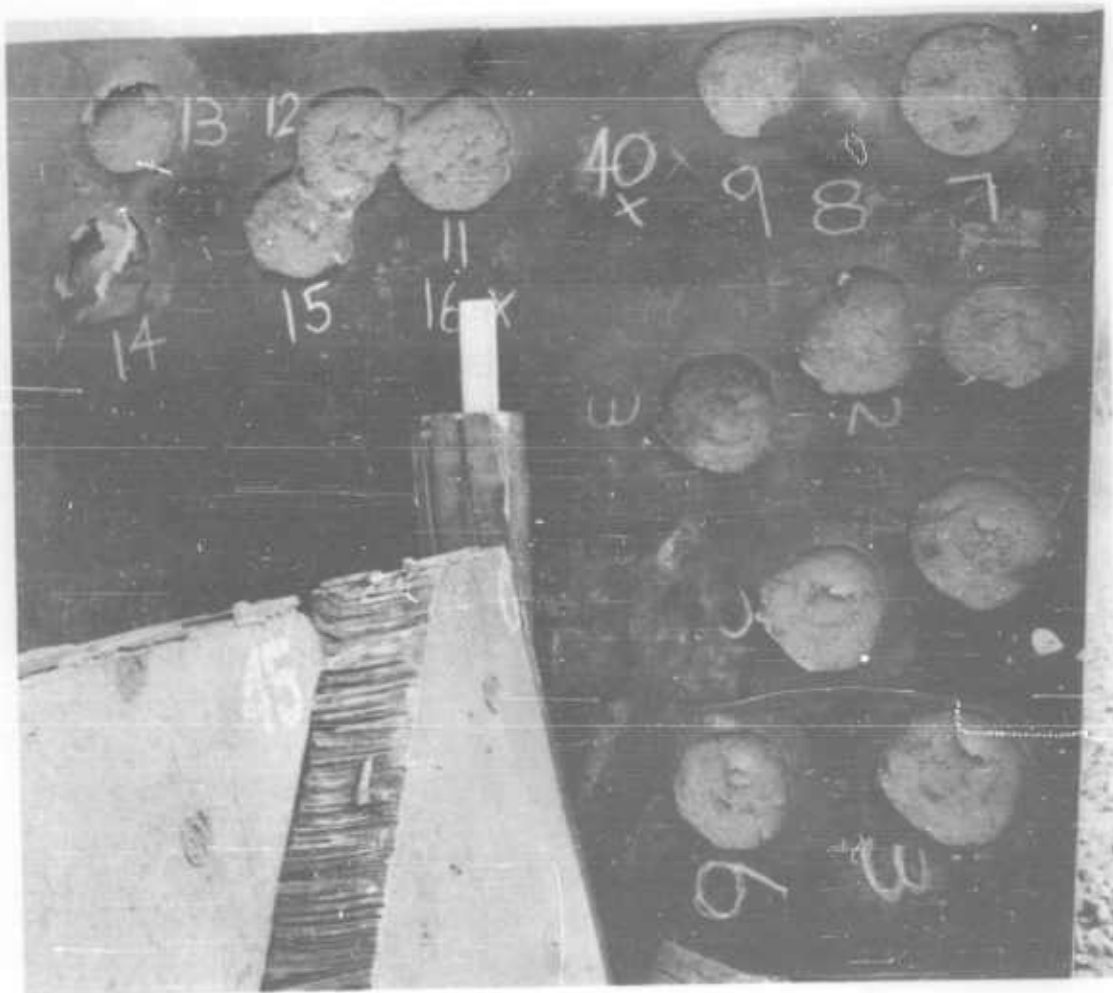
CONFIDENTIAL



B24572: Rear view of four back spalls. Weight of spalls: No. 3 - 48 lbs., No. 7 - 63 lbs., No. 9 - 38 lbs., No. 13 - 27 lbs. 8 inch plate fired at 0 degrees obliquity. Distance from muzzle to plate center - 401 feet.

C-12  
CONFIDENTIAL

CONFIDENTIAL



B24571: Rear of 8 inch armor plate fired at 0 degrees obliquity, showing back spalls from Rounds 7 through 16. Round 8 resulted in a bulge. Round 10 gave no spall due to fuze failure. Charpy value of plate - 71/71, Bhn 225/248. Distance from muzzle to plate center - 401 feet.

C-13

CONFIDENTIAL

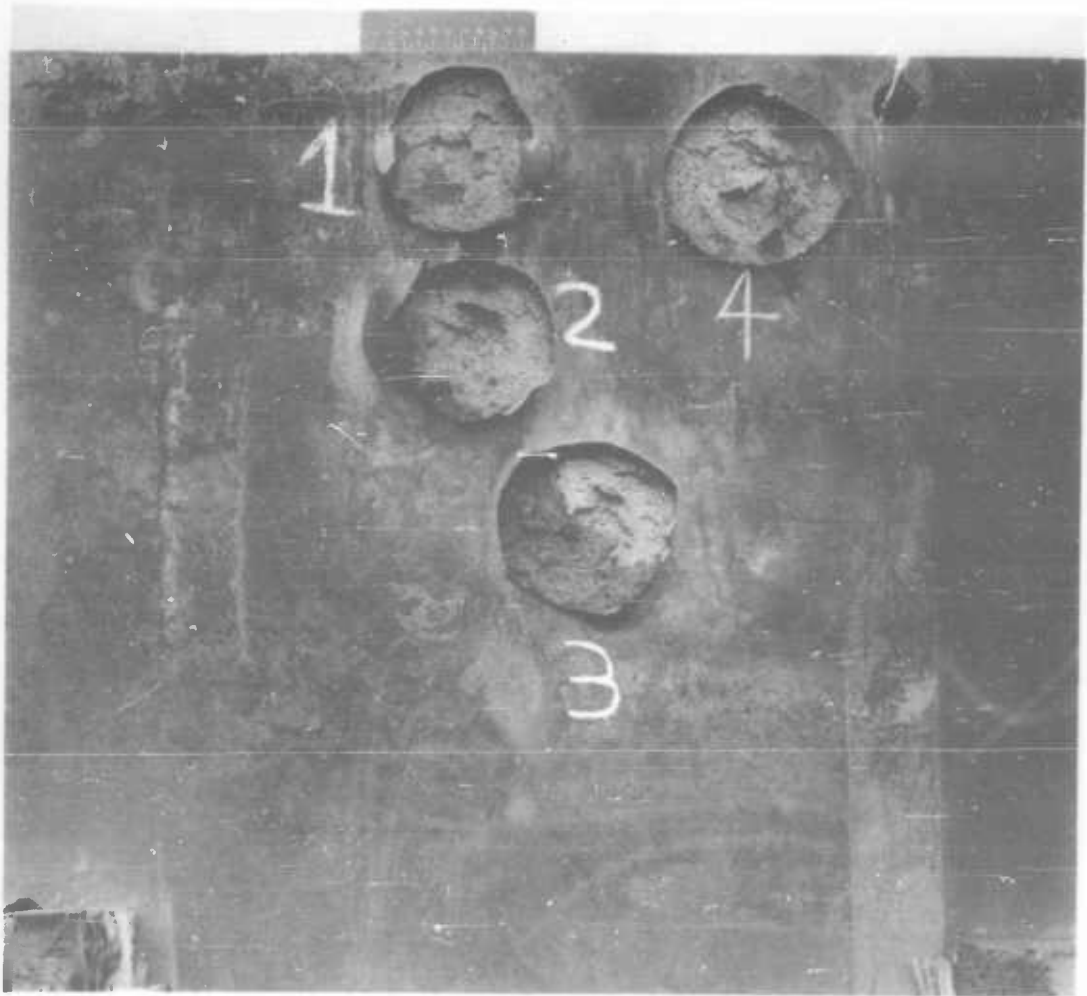
CONFIDENTIAL



B24570: Face of 8 inch armor plate fired at 0 degrees obliquity, showing location of four hits.

C-14  
CONFIDENTIAL

CONFIDENTIAL

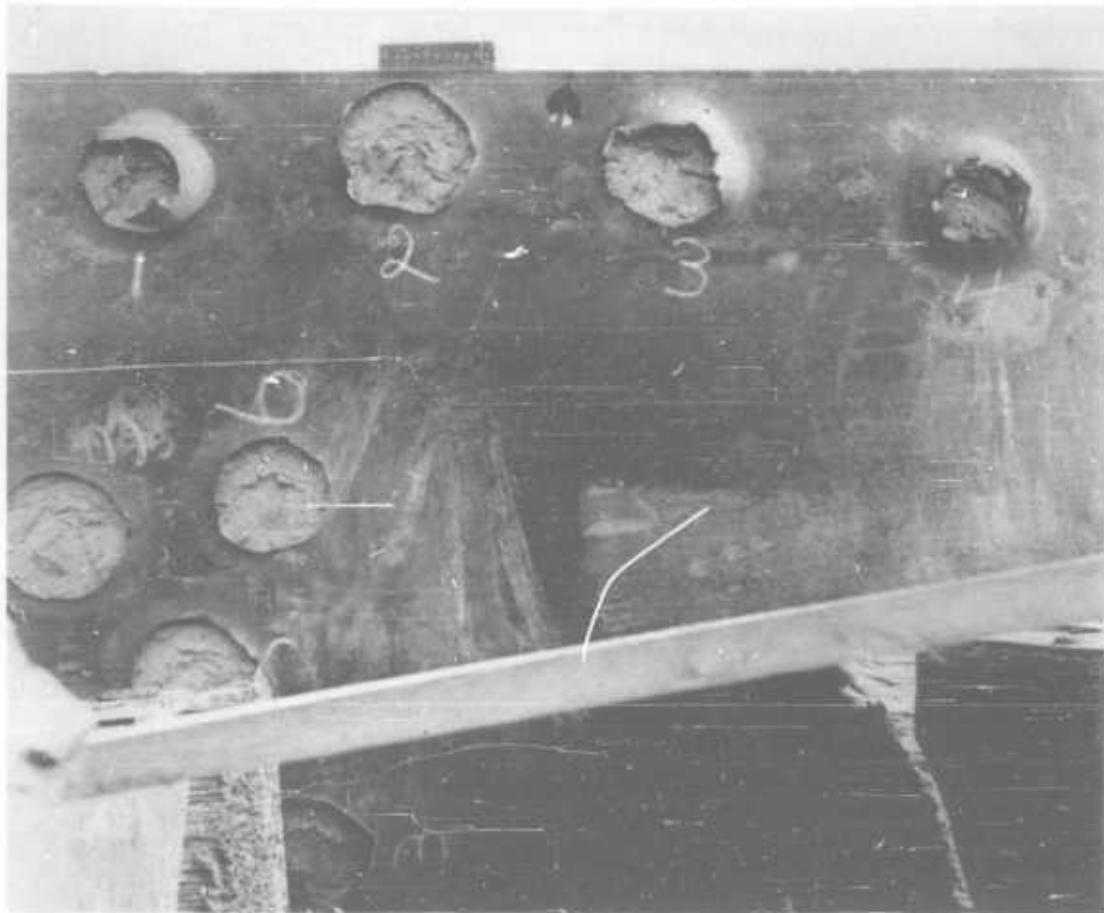


B24569: Rear of 8 inch armor plate fired at 0 degrees obliquity, showing size of back spalls. Spalls 1 and 2 were caused by Shell T152E5. Spalls 3 and 4 by Shell T152E6. Charpy value of plate - 71/71, Bhn 225/248. Distance from muzzle to plate center - 401 feet.

C-15

CONFIDENTIAL

CONFIDENTIAL

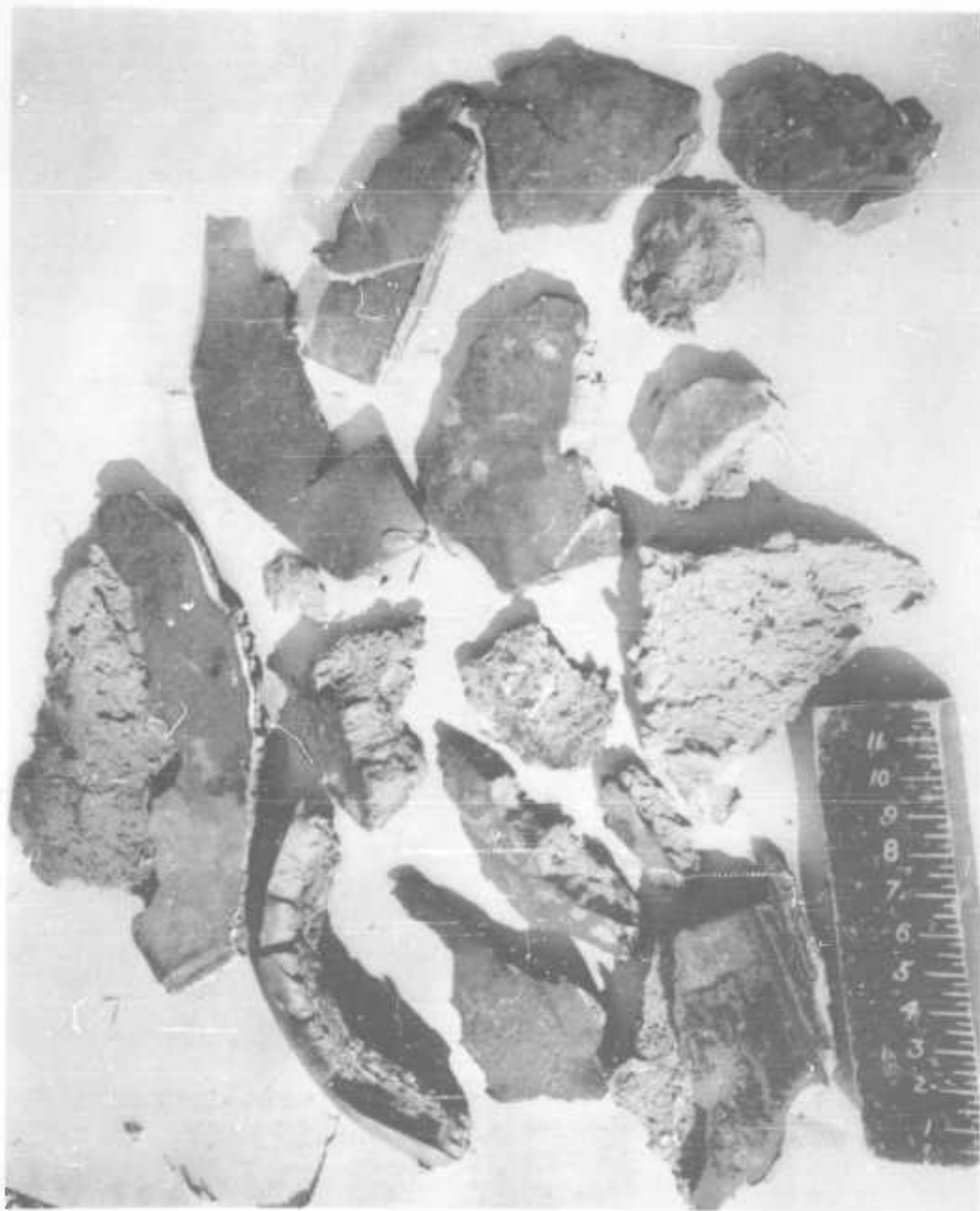


B24587: Rear view of 8-inch plate fired at 0 degrees obliquity, showing back spalls of Rounds 1 - 4. Number 1 and 3, were hit by T152E5 Shell, Number 2 and 4, T152E6. Charpy value of plate 71/71, BHN 225/248. Distance, muzzle to plate center - 401 feet.

C-16

CONFIDENTIAL

**CONFIDENTIAL**



B24586: Photograph of back spall pieces from Round 15 on King Tiger Hull (German). Weight of pieces - 87 lbs.

C-17

**CONFIDENTIAL**

CONFIDENTIAL



B24585: View of hits on King Tiger Hull (German) frontal armor plate. Plate 6 inches thick, 44 degrees obliquity. Arrows indicate broken welds. Distance, muzzle to center of plate - 402 feet.

C-18

CONFIDENTIAL

CONFIDENTIAL



B24584: Three-quarter right front view of King Tiger Hull (German), showing depths of hits. Arrows point to broken welds. Right frontal side suffered similar weld breaks.

C-19

CONFIDENTIAL

CONFIDENTIAL

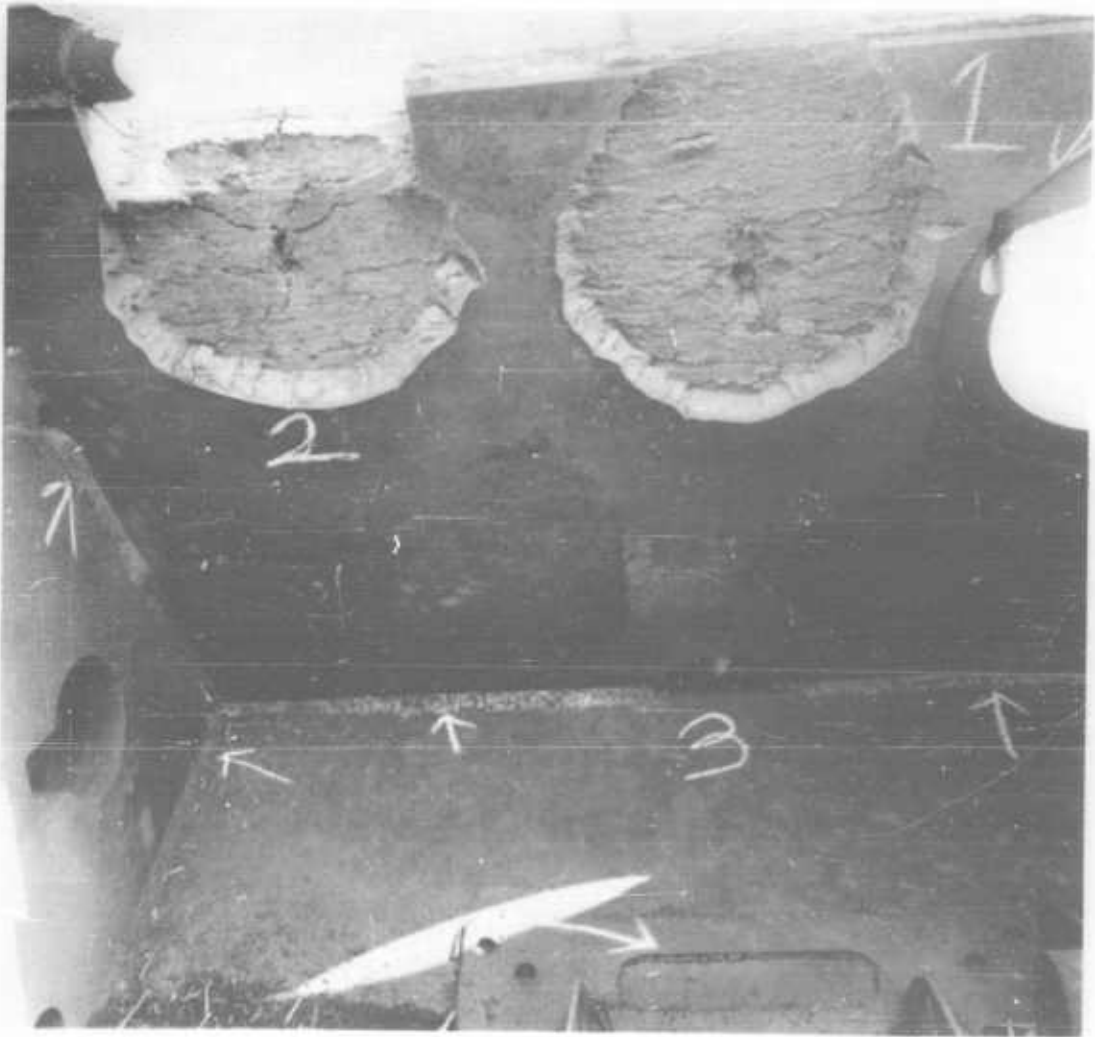


B24583: Interior of King Tiger Hull (German), showing damage caused by back spalls. Three frontal hits.

C-20

CONFIDENTIAL

CONFIDENTIAL

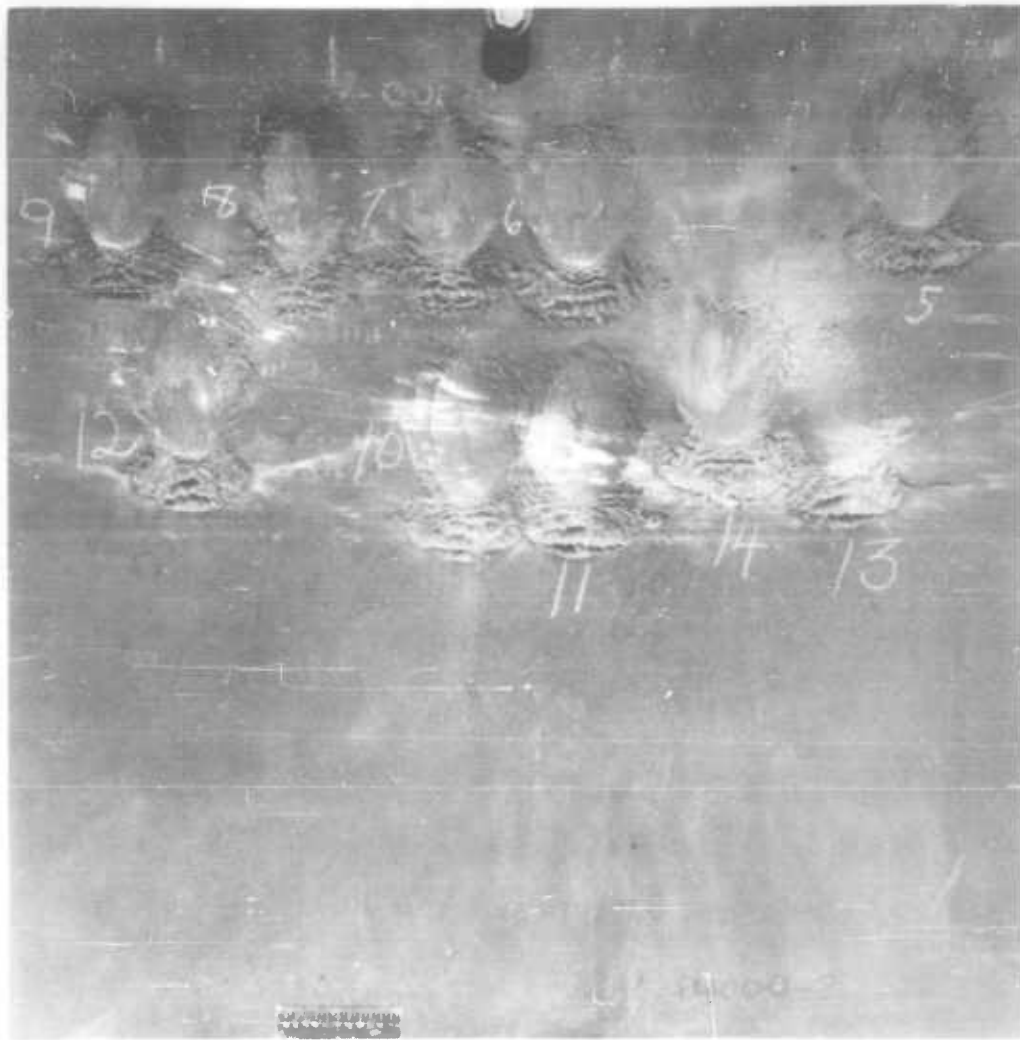


B24582: Rear view of 6-inch frontal plate, showing three hits from 155mm HEP Shell. Hit No. 3 was at junction of two 6-inch plates. Arrows point to broken welds and cracks.

C-21

CONFIDENTIAL

CONFIDENTIAL



B24581: Front view of 7-inch plate fired at 60 degrees obliquity, showing imprints of hits. Rounds 5 and 6 were fired muzzle to plate center 241 feet. Rounds 7 - 14, muzzle to plate center - 400 feet.

C-22  
CONFIDENTIAL

CONFIDENTIAL



B24580: Rear view of 7-inch plate fired at 60 degrees obliquity, showing back spalls from Rounds 5 - 14. Rounds 5, 7, 9, 11, and 13 were T152E5. Rounds 6, 8, 10, 12, and 14 were T152E6. Charpy value of plate - 57/34, BHN 229.

C-23

CONFIDENTIAL

CONFIDENTIAL

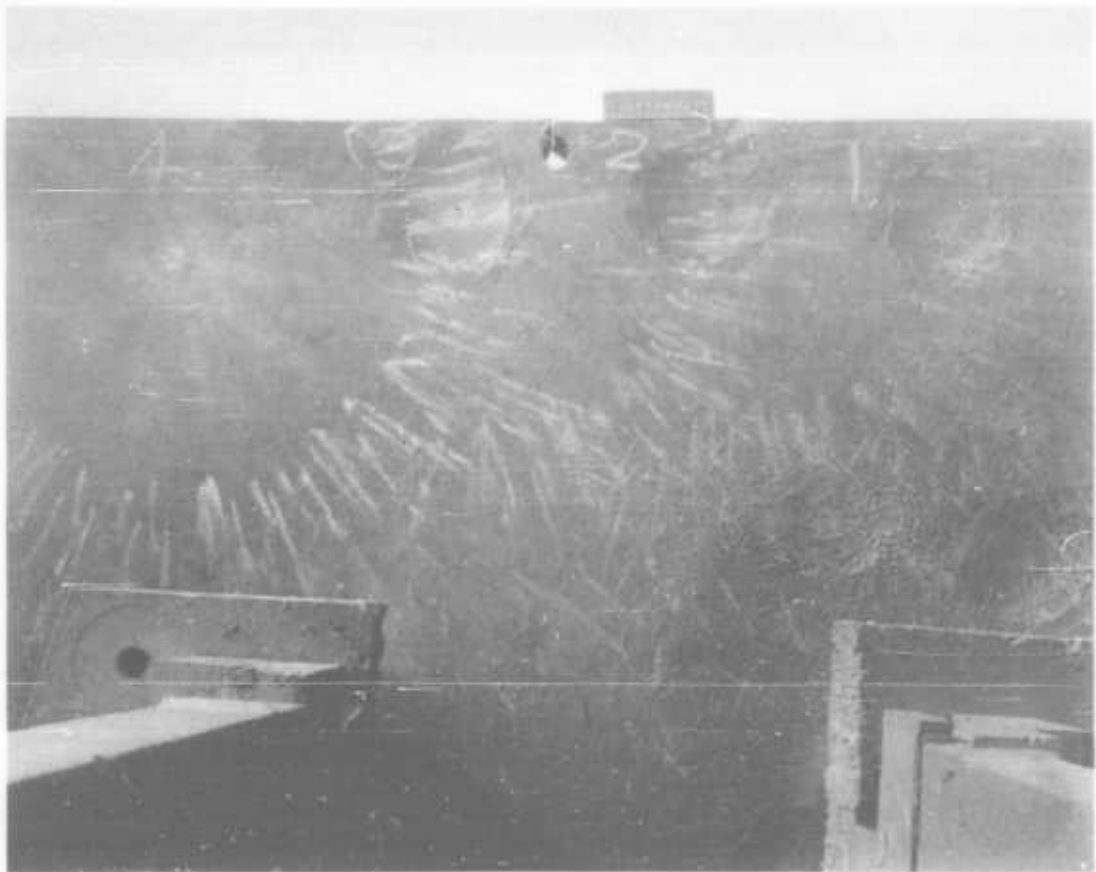


B24579: View of back spalls from 7-inch plate fired at 60 degrees obliquity. Distance, muzzle to center of plate - 400 feet. Average weight of spalls - 51 lbs.

C-24

CONFIDENTIAL

**CONFIDENTIAL**

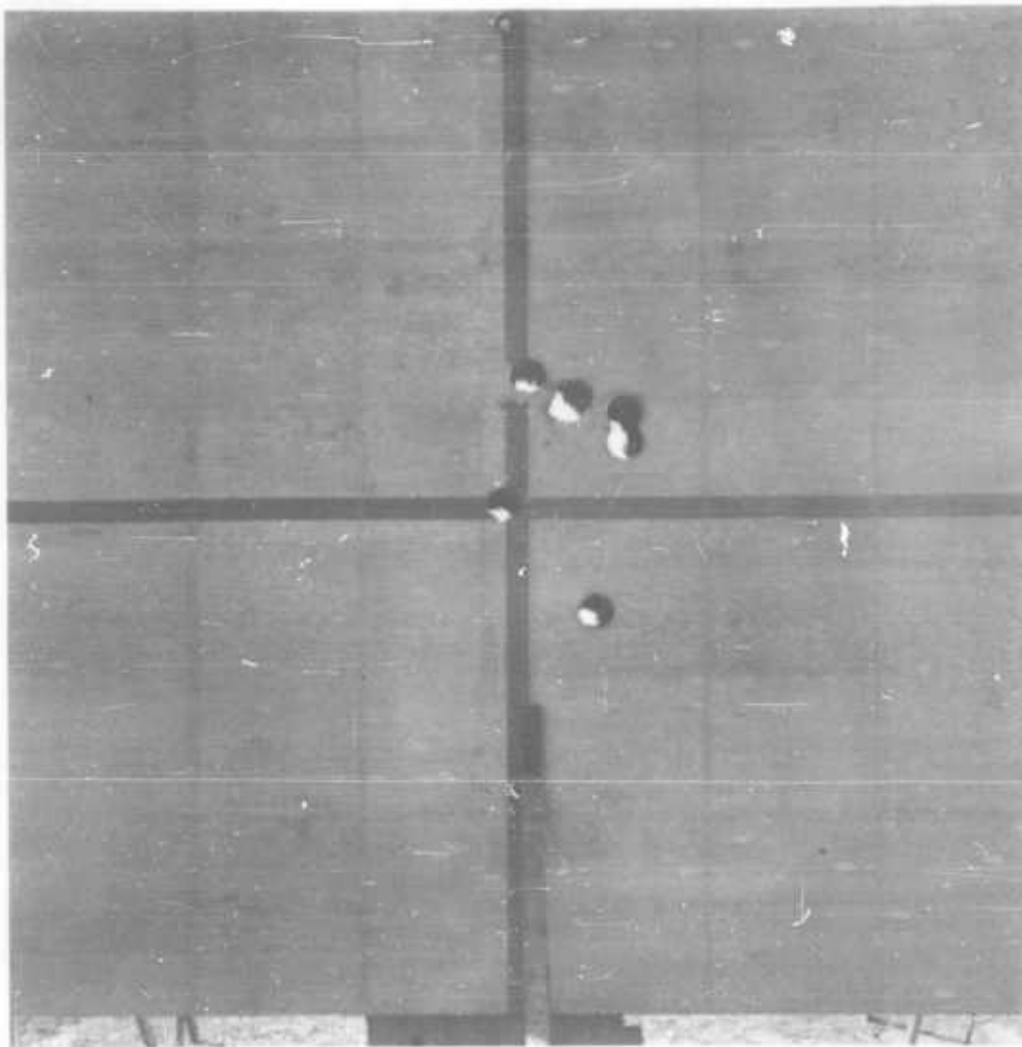


B24578: Front view of 8-inch plate fired at 0 degrees obliquity, showing four hits on plate. Depth of hits average  $1 \frac{1}{4}$  inches.

C-25

**CONFIDENTIAL**

CONFIDENTIAL

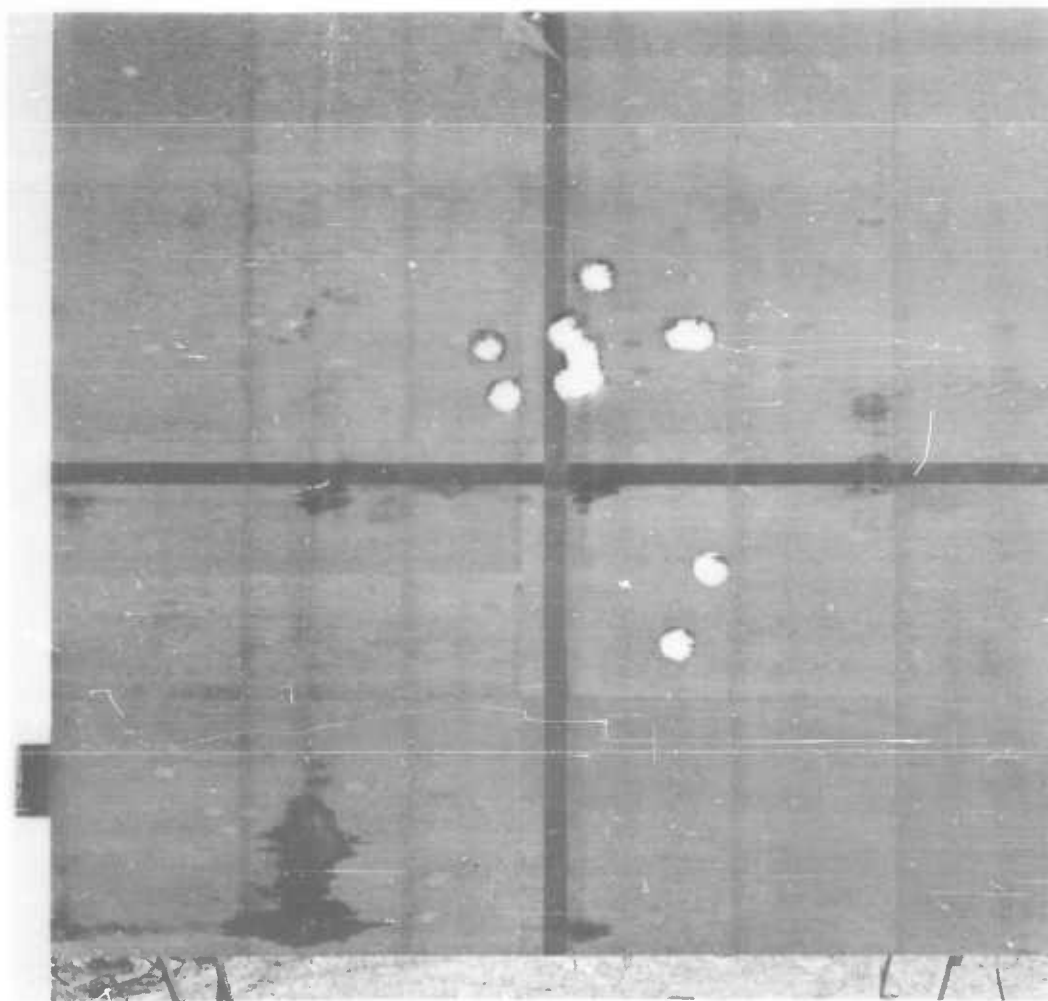


B22001: Hits on 1000 yard accuracy target with T152E5 HEP Shell. Vertical PE .31 mils reduces to .09 omitting round in lower right hand quadrant. Lateral PE .11.

C-26

CONFIDENTIAL

CONFIDENTIAL

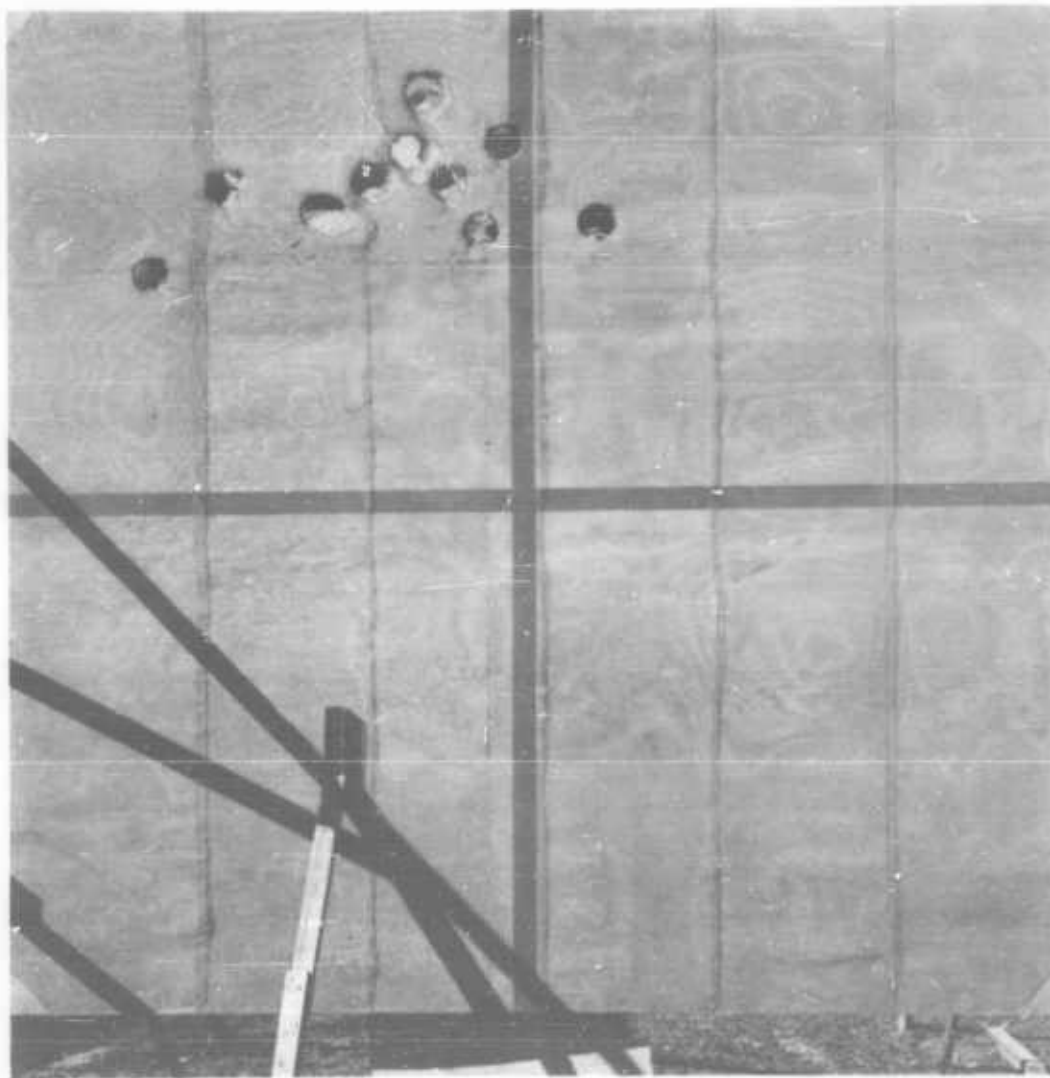


B22002: Hits on 1000 yard accuracy target with T152E5 HEP Shell. Vertical P.E. .39 reduces to .13 omitting two rounds in lower right hand quadrant. Lateral P.E. .27 mils.

C-27

CONFIDENTIAL

CONFIDENTIAL

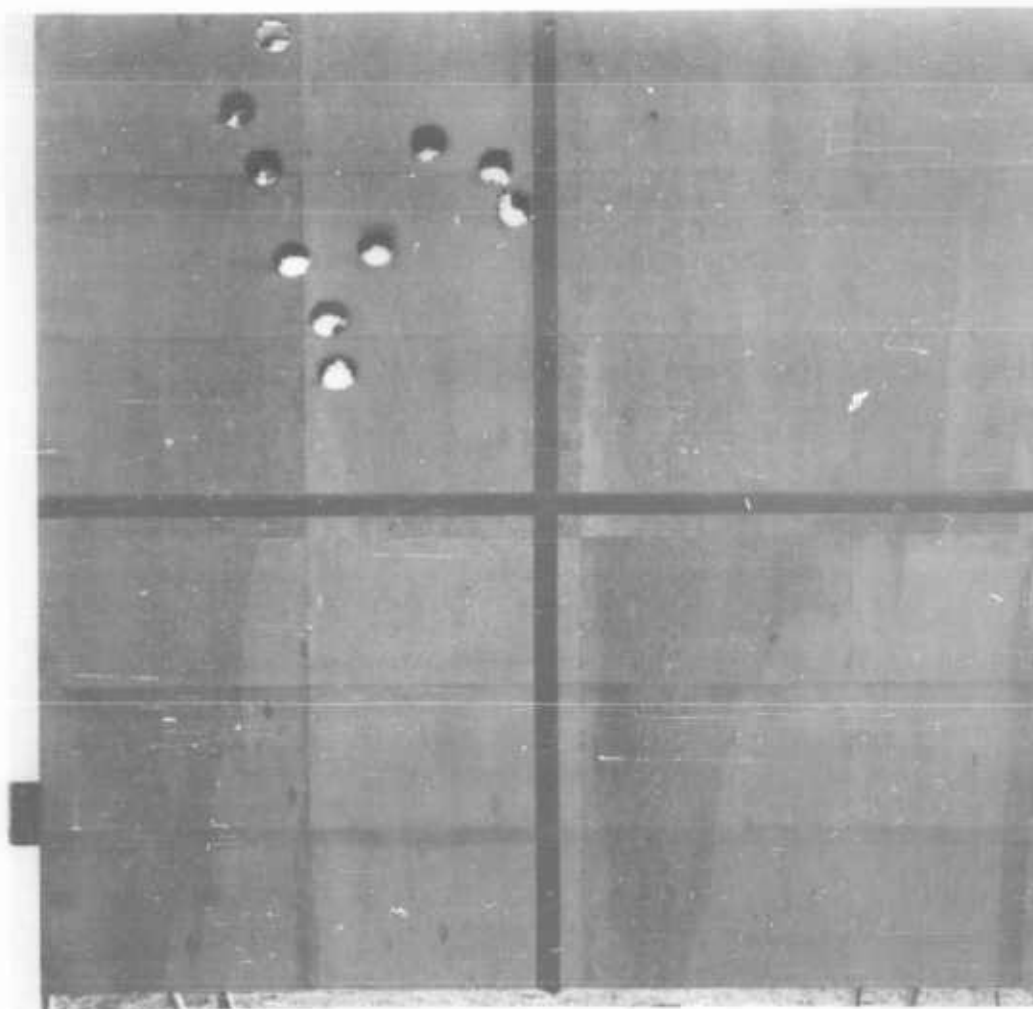


B22003: Hits on 1000 yard accuracy target with T152E6 HEP Shell. Vertical P.E. .14 mils. Lateral P.E. .34 mils.

C-28

CONFIDENTIAL

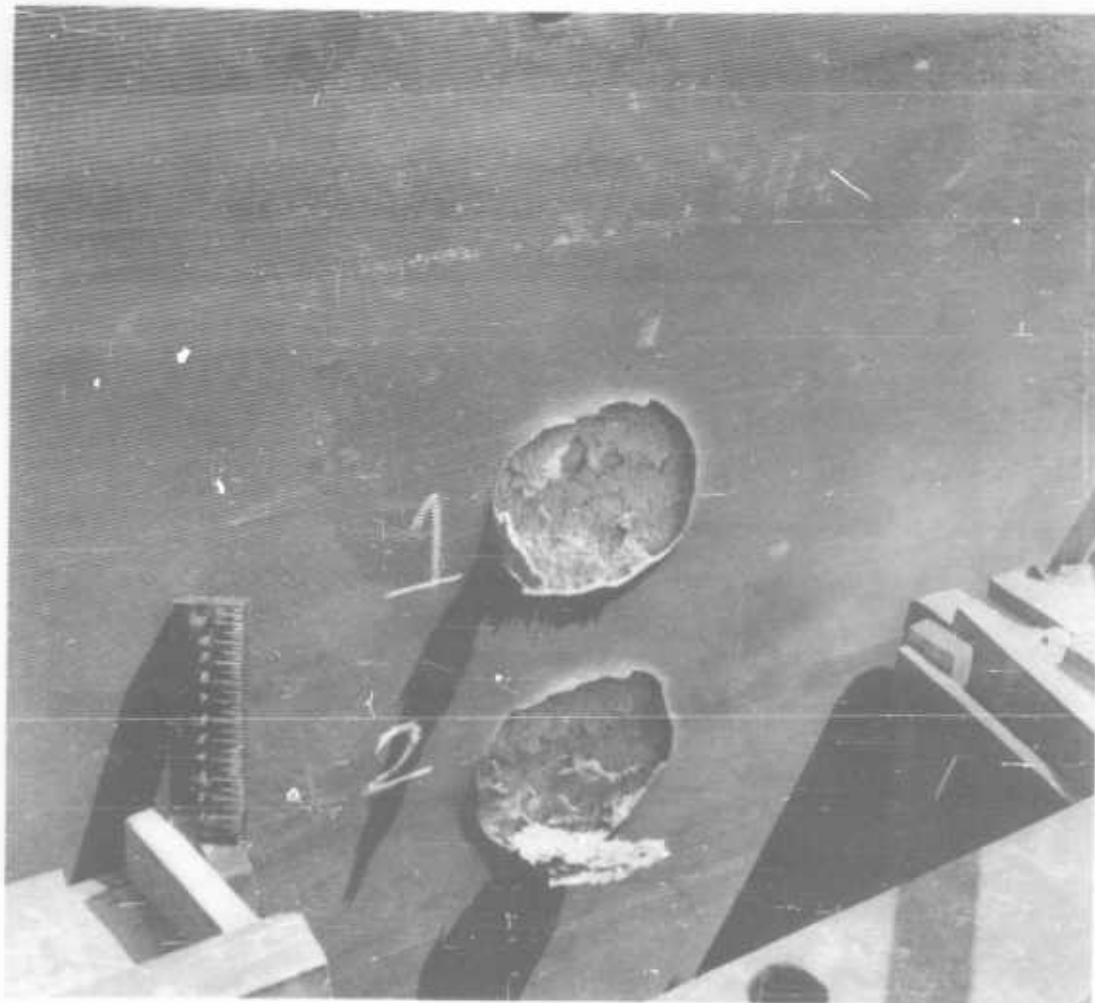
CONFIDENTIAL



B22004: Hits on 1000 yard accuracy target, with T152E5 HEP Shell. Vertical P.E. .34 mils. Lateral P.E. .32 mils.

C-29  
CONFIDENTIAL

CONFIDENTIAL

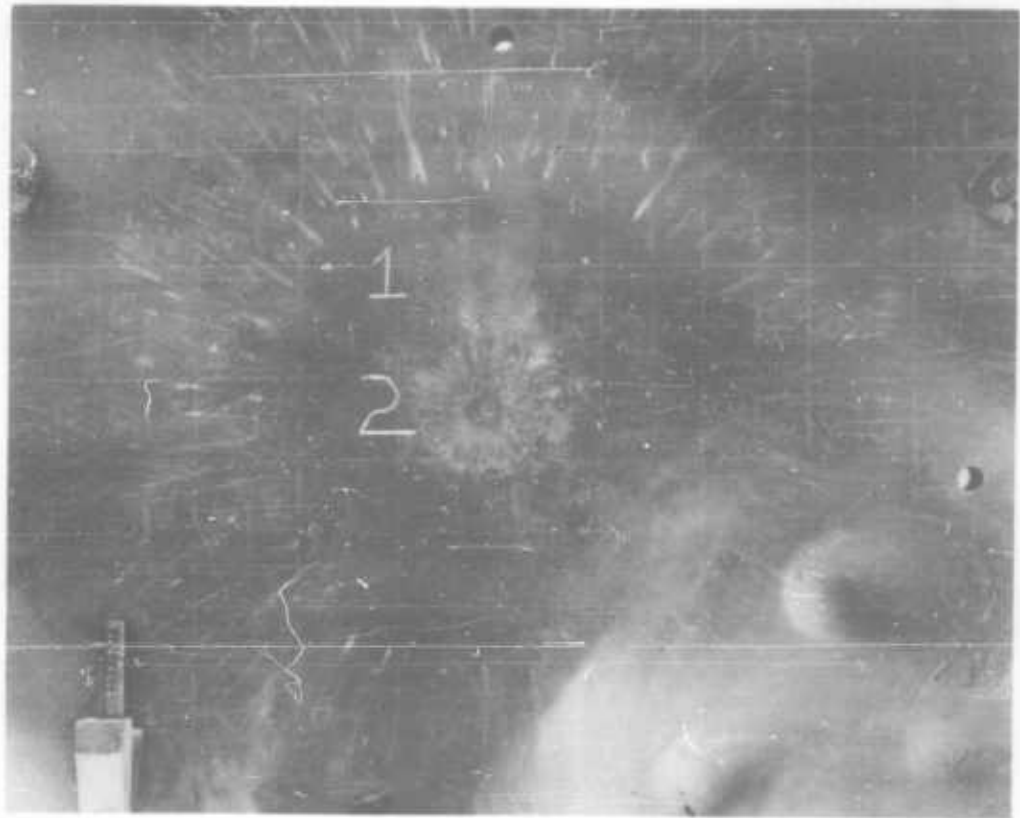


B22005: Rear view of 8-inch plate fired at 1000 yards, zero degrees obliquity, showing back spalls from Rounds 1 and 2. Round 1, T152E6; Round 2, T152E5. Charpy value of plate - 62, BHN 241. Depth of spalls average 2 1/4 inches.

C-30

CONFIDENTIAL

CONFIDENTIAL

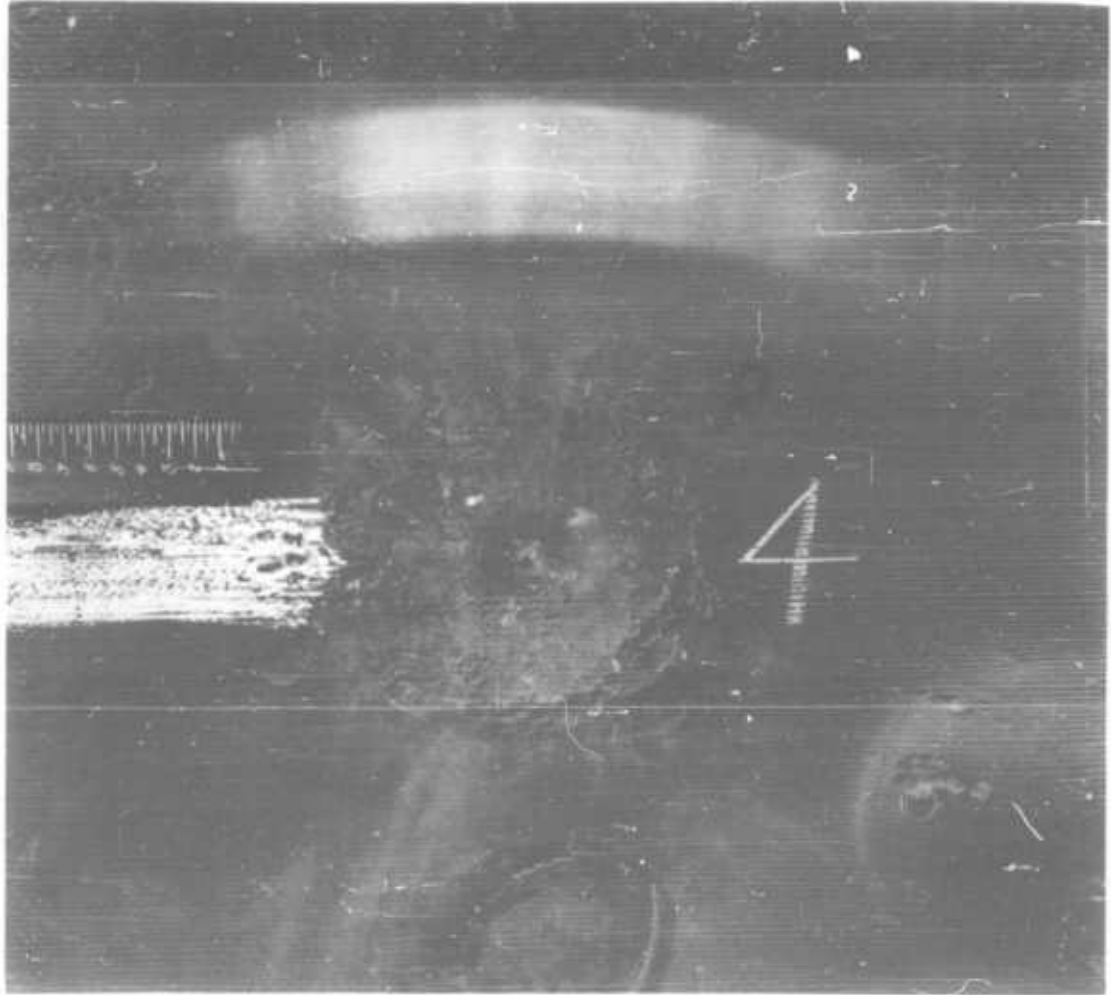


B22006: Front view of 8-inch plate fired at 1000 yards, zero degrees obliquity showing first hits on plate. Depth of hits average  $1 \frac{1}{8}$  inches.

C-31

CONFIDENTIAL

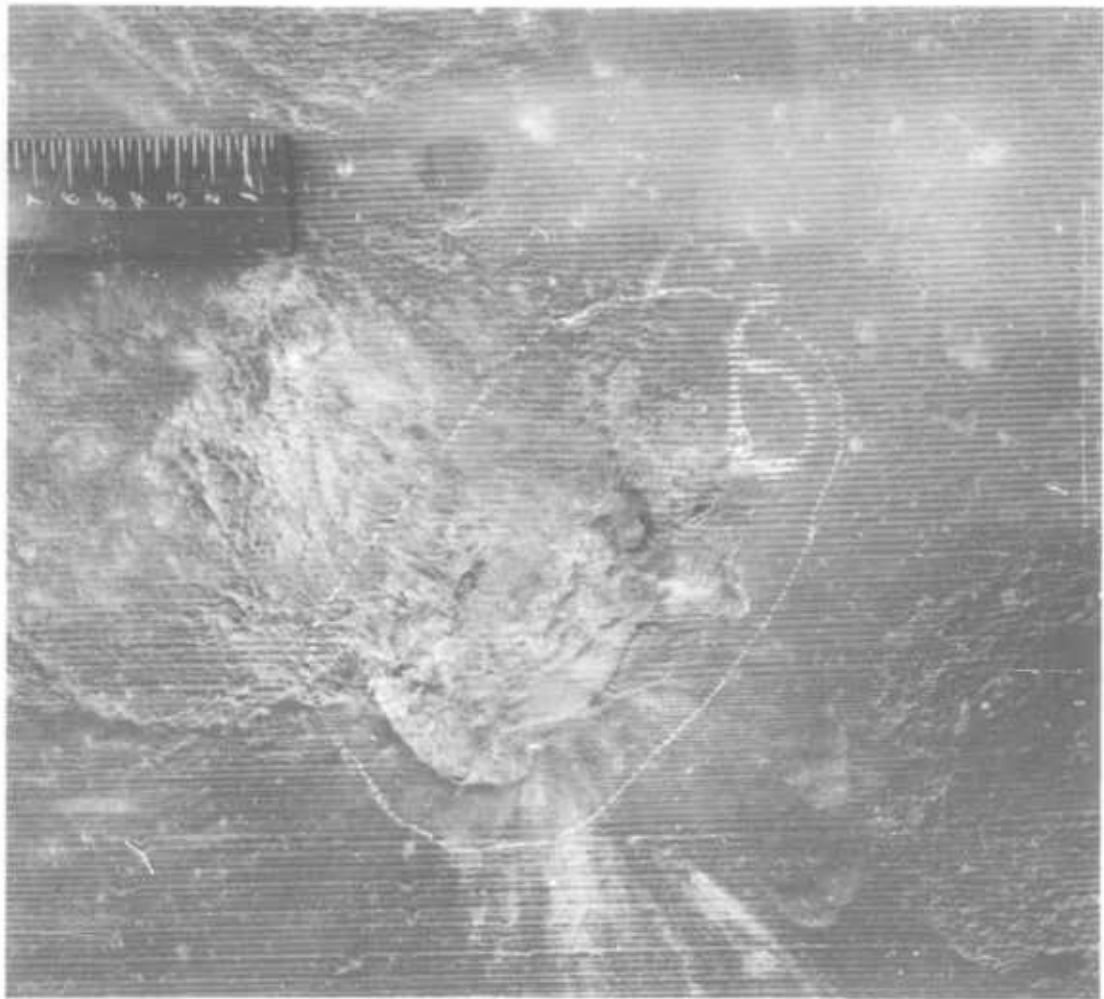
CONFIDENTIAL



B22007: Front view of 8-inch plate fired at 1000 yards, zero degrees obliquity showing Round 4. Depth of hit - one inch.

C-32  
CONFIDENTIAL

CONFIDENTIAL

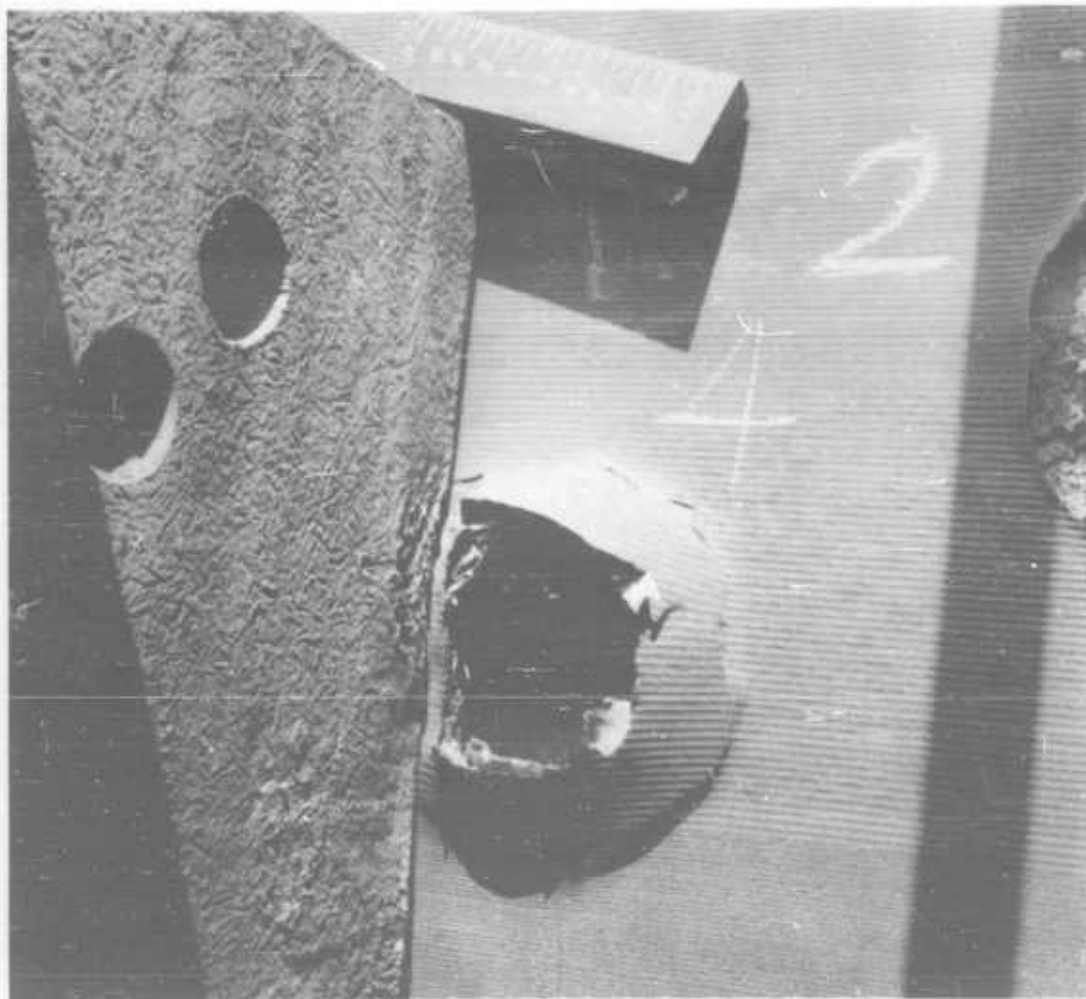


B22008: Front view of 8-inch plate fired at 1000 yards, zero degrees obliquity showing hit. This round was of low order due to fuze failure (T152E6).

C-33

CONFIDENTIAL

CONFIDENTIAL



B22009: Rear view of 8-inch plate fired at 1000 yards, zero degrees obliquity, showing back spall from Round 4. T152E6. Depth of spall - 2 inches. Charpy value of plate - 62, BHN 241.

C-34

CONFIDENTIAL

CONFIDENTIAL

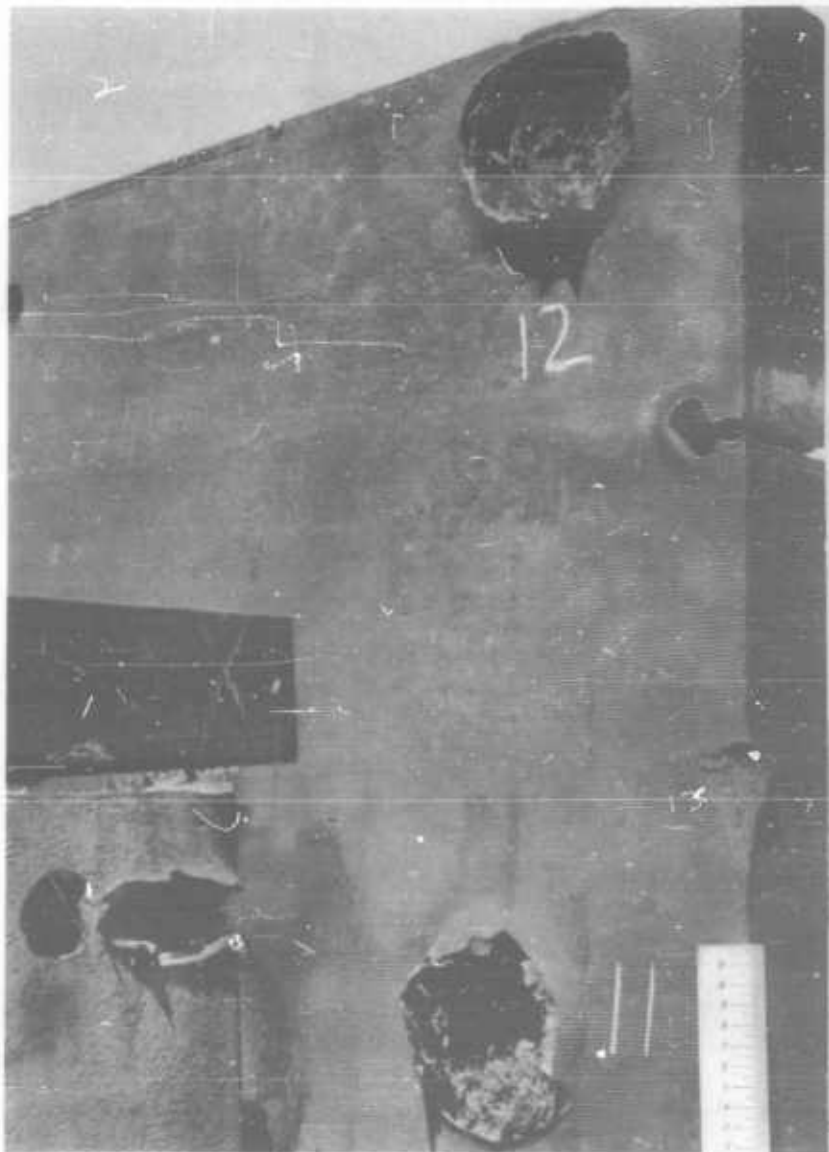


B22045: Front view of plate showing hits on 7-inch plate at 1000 yards with plate set at 0 degrees obliquity and splatter plate. The hole that is directly in front of the splatter plate was caused by Round 7 which fell short. The hit that bulged the splatter plate was caused by Round 8.

C-35

CONFIDENTIAL

CONFIDENTIAL

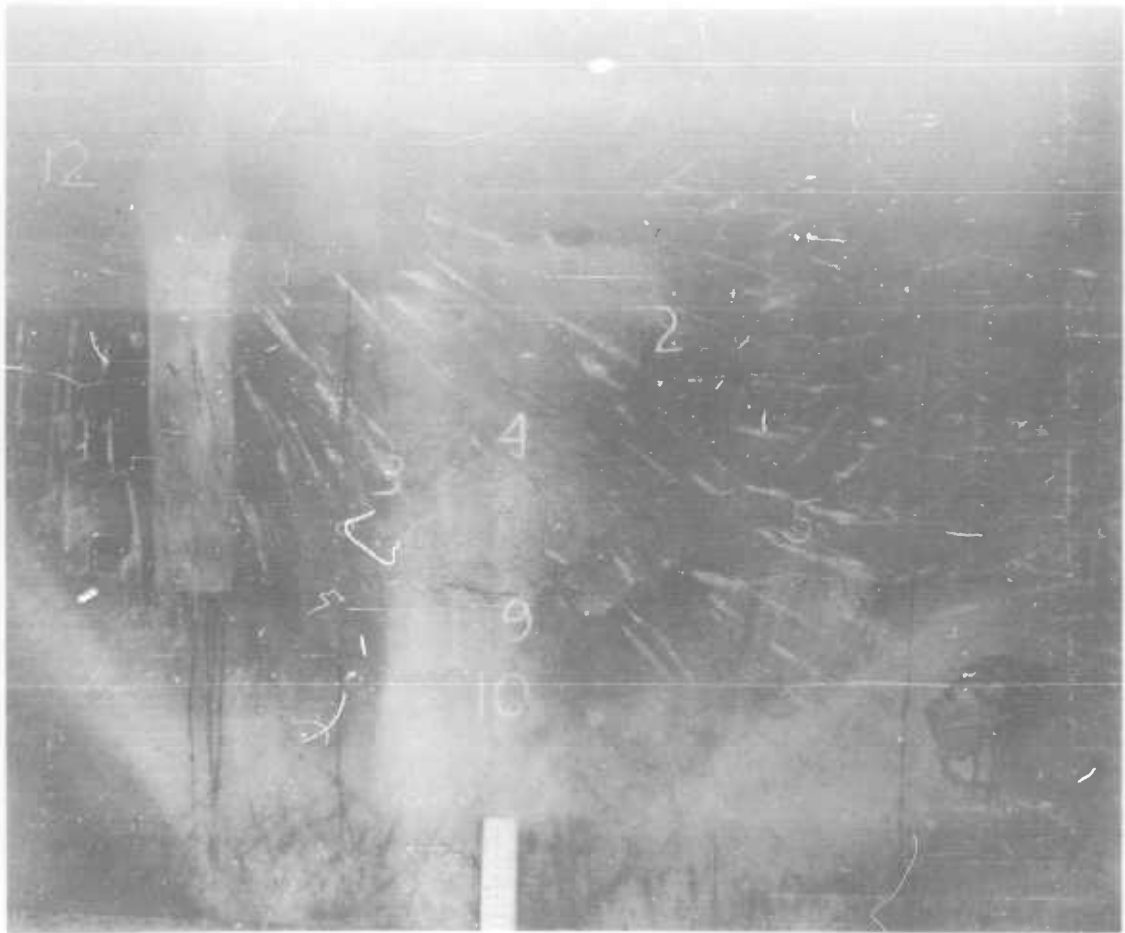


B22046: Rear view of 8-inch plate fired at 1000 yards at 0 degree obliquity showing back spalls of Round 11, T152E5 and Round 12, T152E6. The depth of the back spalls averaged 1-7/8 inches. Charpy value of the plate was 62, BHN 241.

C-36

CONFIDENTIAL

CONFIDENTIAL

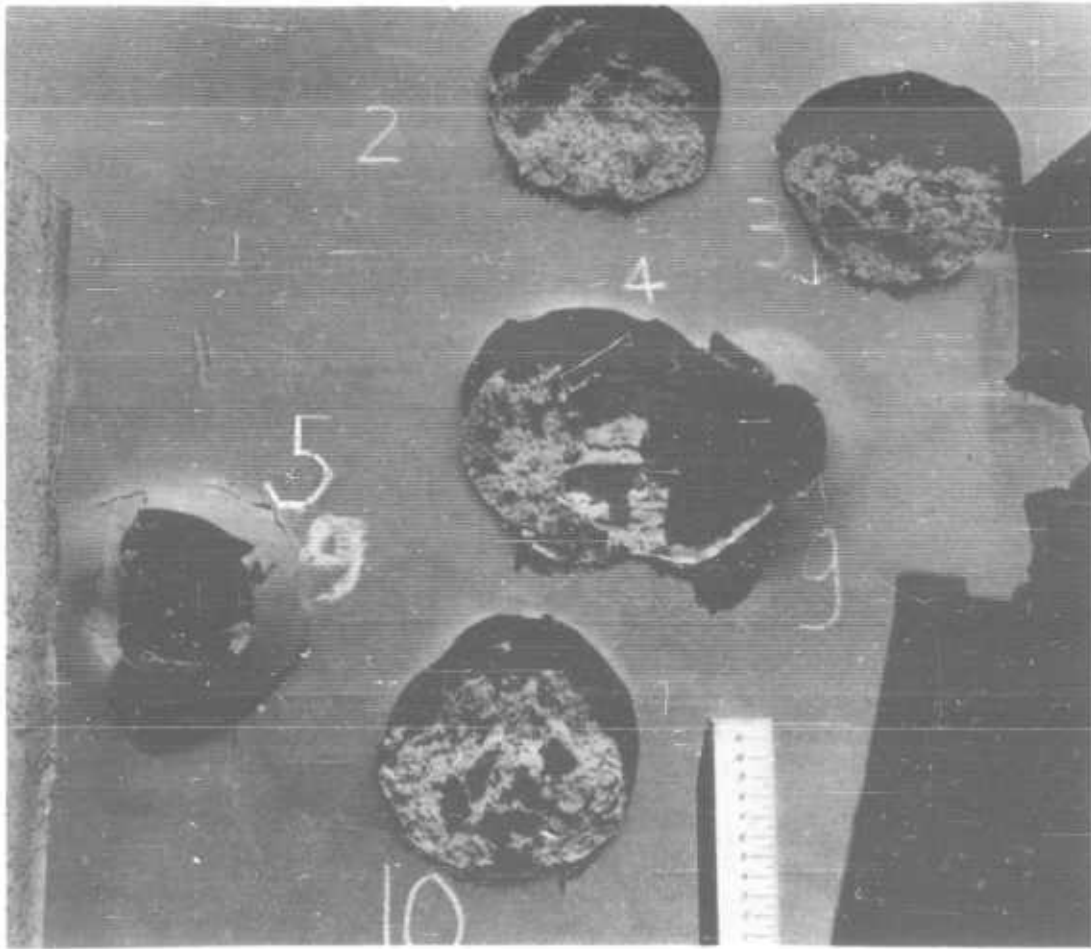


B22047: Front view of 8-inch plate fired at 1000 yards at 0 degrees obliquity showing hits on plate. Rounds 1, 6, 7 and 8 missed the plate. Rounds 3, 5, 9 and 11, T152E5 and Rounds 2, 4, 10 and 12, T152E6.

C-37

CONFIDENTIAL

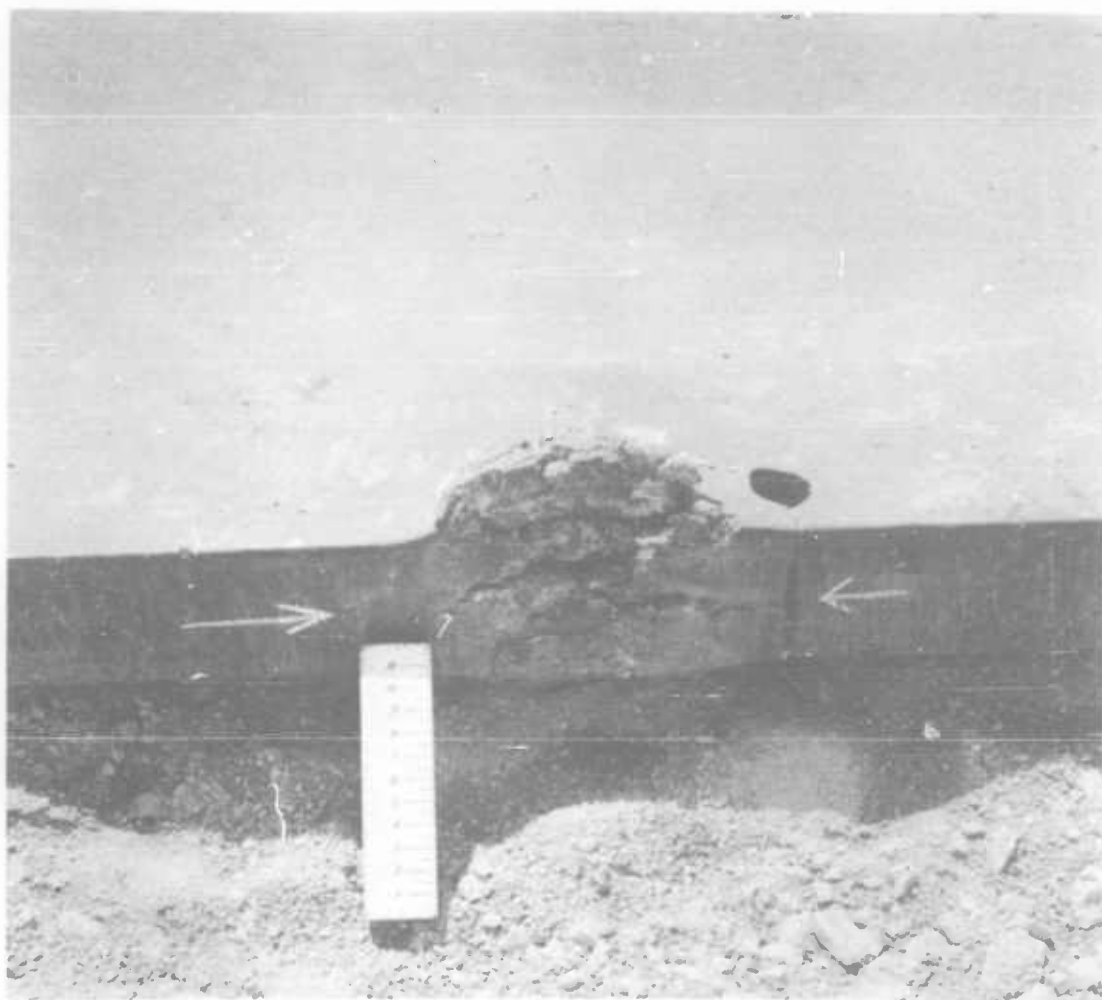
CONFIDENTIAL



B22048: Rear view of 8-inch plate fired at 1000 yards at 0 degree obliquity showing back spalls from Rounds 2, 3, 4, 5, 9 and 10. Rounds 3, 5, and 9 were T152E5; Rounds 2, 4 and 10 were T152E6. Charpy value of the plate was 62, BHN 241.

C-38  
CONFIDENTIAL

CONFIDENTIAL

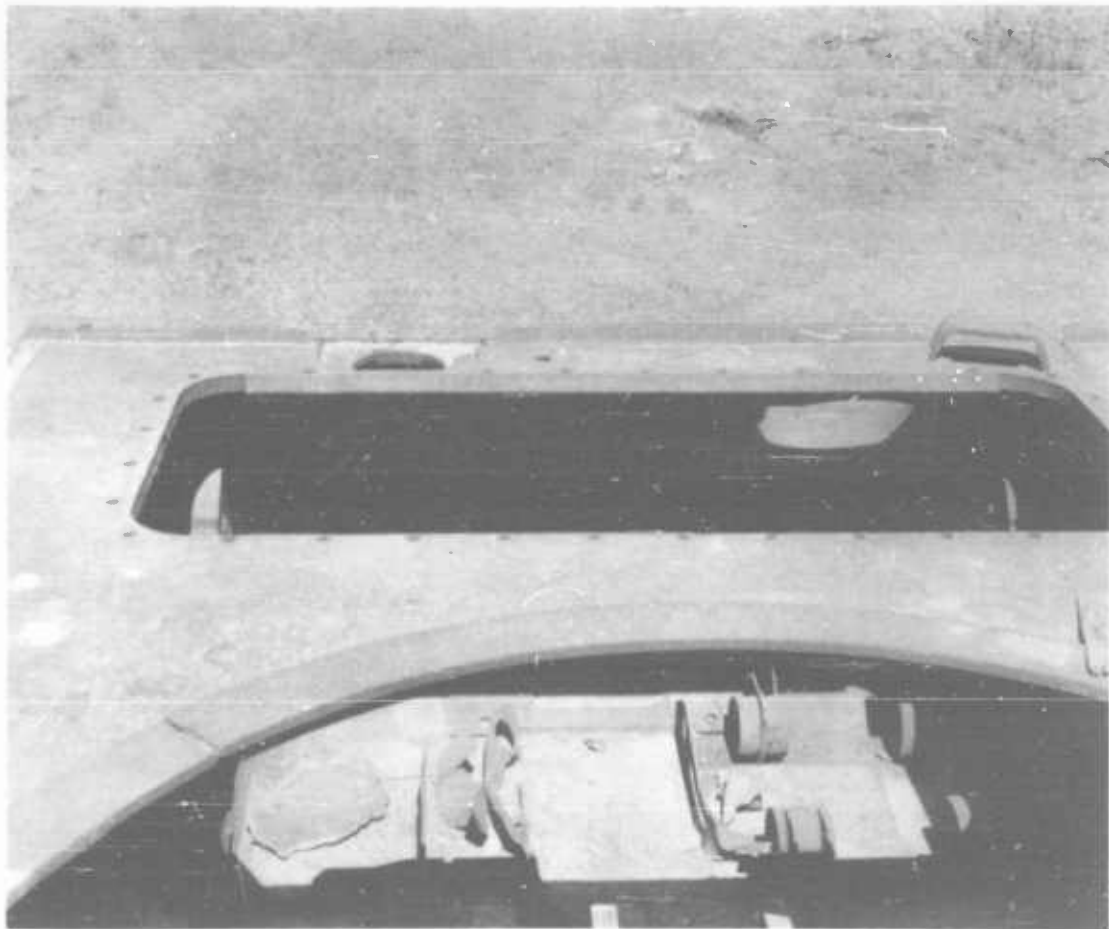


B22049: Hit on 5-inch splatter plate showing laminations. The petaling effect occurred on both sides of the plate. The depth of the cracks extend 7 inches in the center of the arrows. This was Round 8, T152E6.

C-39

CONFIDENTIAL

CONFIDENTIAL



B24635: Interior of King Tiger Hull (German) fired at 1300 yards showing spall and back spall damage. Arrows indicate broken welds. Depth of back spall 2 inches.

C-40  
CONFIDENTIAL

CONFIDENTIAL



B24636: Front view of King Tiger Hull (German) fired at 1300 yards showing hit on frontal plate which was 44 degrees obliquity. Round 13, T152E5. Arrows indicate broken welds. Depth of hit was 1 1/4 inches.

C-41

CONFIDENTIAL

CONFIDENTIAL

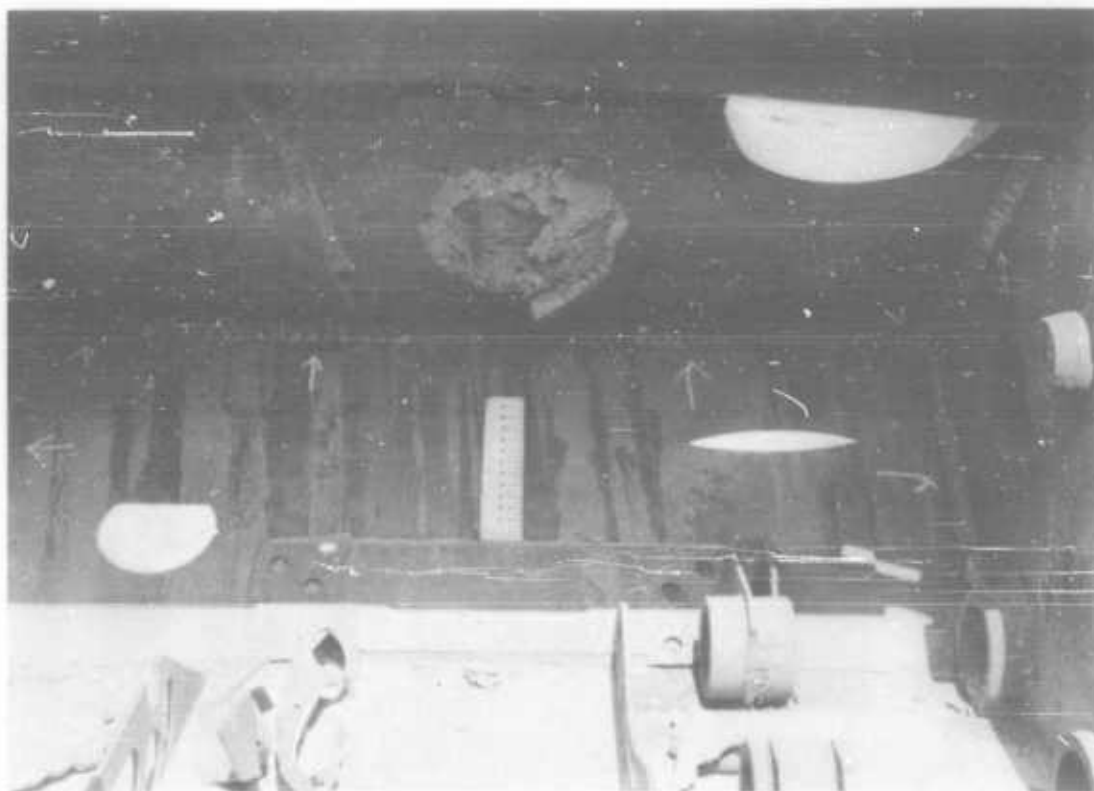


B24637: Side frontal view of King Tiger Hull (German) fired at 1300 yards showing extent of damage and depth of hit. Arrows indicate broken welds.

C-42

CONFIDENTIAL

CONFIDENTIAL

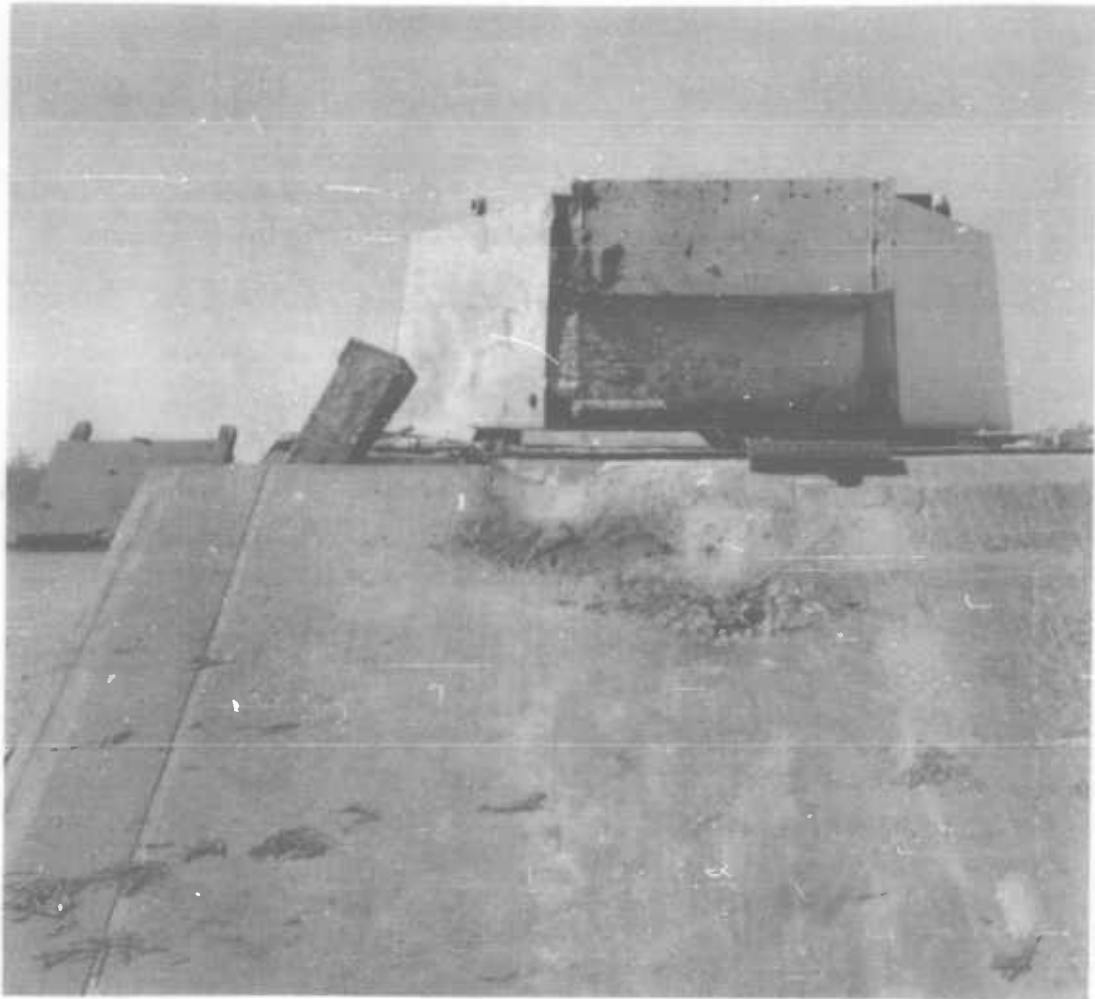


B24638: View of back spall of King Tiger Hull (German) fired at 1300 yards showing back spall. Depth of back spall, 2 inches.

C-43

CONFIDENTIAL

CONFIDENTIAL



B24755: Front view of 7-inch plate fired at 1000 yards at 60 obliquity, showing hits on plate. The top of the plate was supported by a M36, Gun Motor Carriage.

C-44

CONFIDENTIAL

CONFIDENTIAL



B24756: Photograph of M36, Gun Motor Carriage, showing position of turret after hit by Shell, HEP, 155mm, T152E6, at base of turret ring. The top plates of the turret have been blown off. Range fired at: 1000 yards.

C-45

CONFIDENTIAL

CONFIDENTIAL



B24757: Side view of M36, Gun Motor Carriage, showing damage caused by hit of Shell, HEP, 155mm, T152E6, at base of turret. Range fired at: 1000 yards.

C-46  
CONFIDENTIAL

CONFIDENTIAL



B24758: Interior view of turret, M36, Gun Motor Carriage, showing damage caused by one hit of Shell, HEP, 155mm, T152E6.

C-47  
CONFIDENTIAL

CONFIDENTIAL

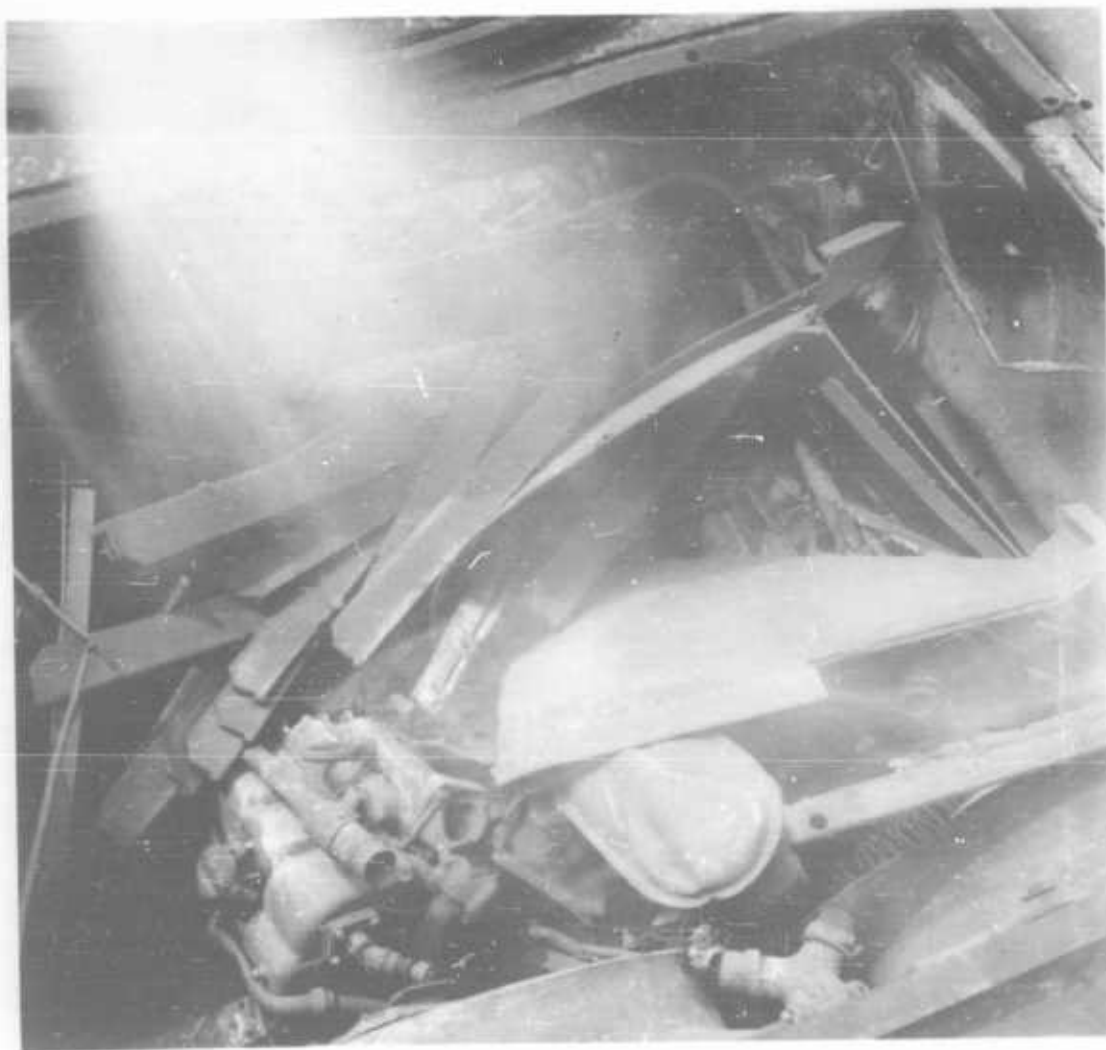


B24759: Rear view of Turret, M36 Gun Motor Carriage, showing damage. Arrow indicates point of hit by Shell, HEP, 155mm, T152E6.

C-48

CONFIDENTIAL

CONFIDENTIAL



B24760: View of motor compartment, M36 Gun Motor Carriage, showing damage caused by Shell, HEP, 155mm, T152E6.

C-49

CONFIDENTIAL

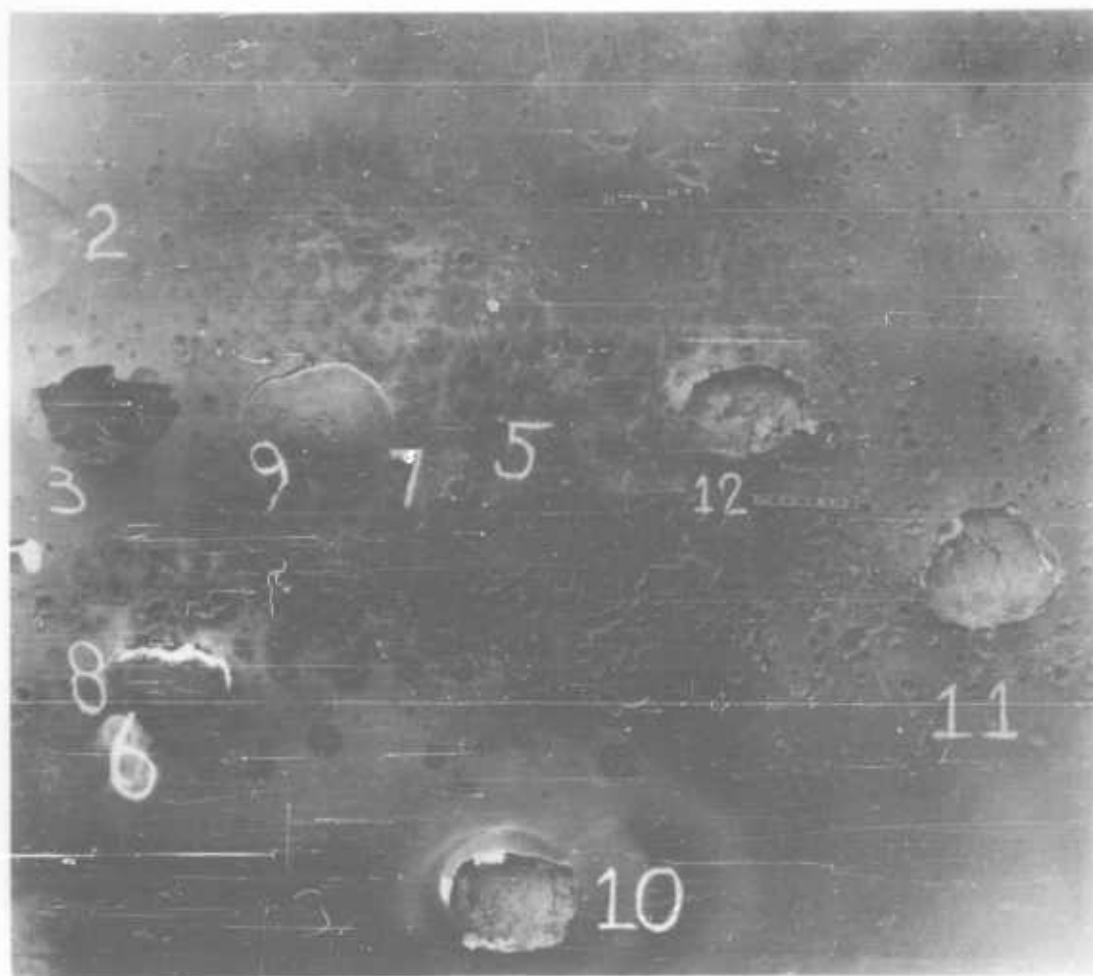
CONFIDENTIAL



B25724: Front view of 7-inch plate fired at 1000 yards, 60° obliquity - showing ten hits on plate which had a charpy value of 103/91, BHN 235/232. Round Nos. 1 and 4 missed the plate. Round No. 8 was low order.

C-50  
CONFIDENTIAL

CONFIDENTIAL



B25725: Rear view of 7-inch plate fired at 1000 yards, 60° obliquity - showing ten hits on plate which had a charpy value of 103/91, BHN 235/232.

C-51

CONFIDENTIAL

CONFIDENTIAL



B25726: Rear view of 7-inch plate fired at 1000 yards, 60° obliquity - showing back spall of Round 10, depth of spall is 3/4 inch size of spall is 15" x 12". Interior of spall is laminated.

C-52

CONFIDENTIAL

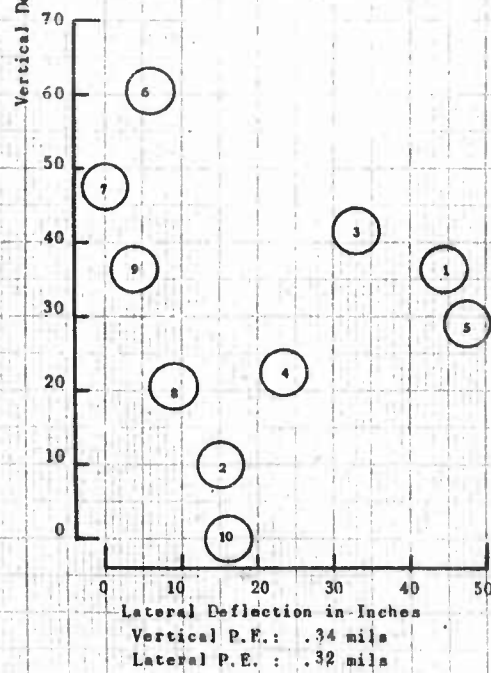
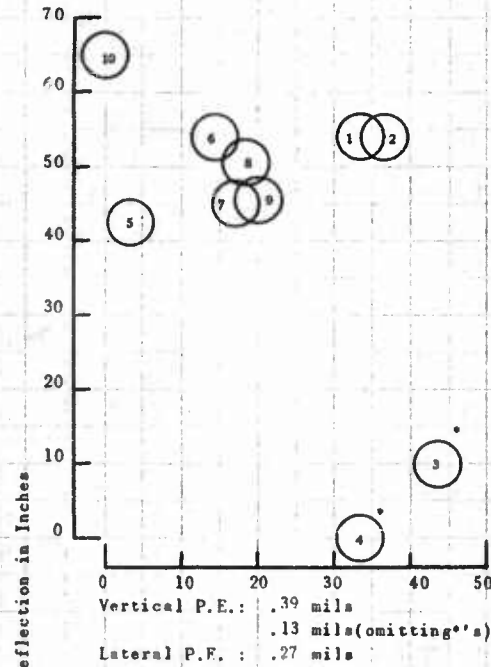
CONFIDENTIAL

APPENDIX D

VERTICAL TARGET ACCURACY

Shell: HEP, 155mm, T152E5  
Fired from: 155mm Howitzer M1

Date fired: 10 April 57  
Range: 999.45 yards



Anal Lab, Engr Labs, DEPS  
18 Apr 57 SGO

D-1  
CONFIDENTIAL

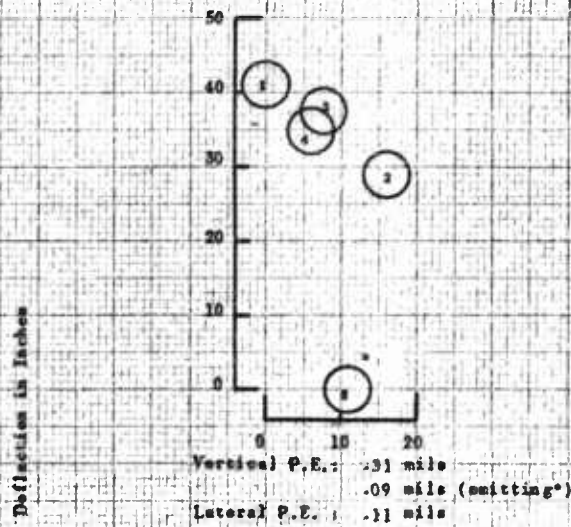
CONFIDENTIAL

Shell: HEP, 155mm, T152E5, E6  
Fired from: 155mm Howitzer M1

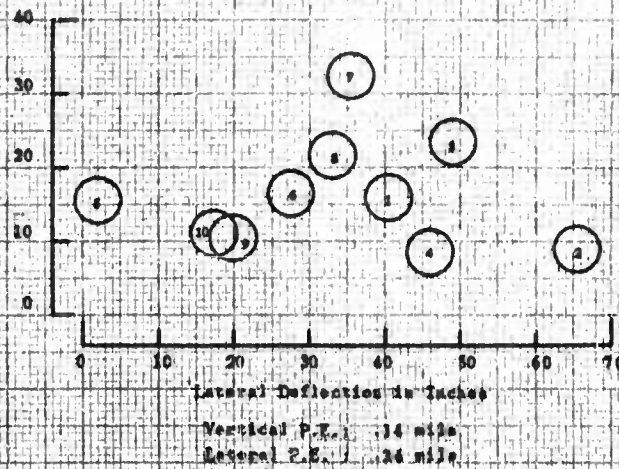
VERTICAL TARGET ACCURACY

Date fired: 10 and 11 April 57  
Range: 999.45 yards

Shell: T152E5  
Date fired: 11 April 57



Shell: T152E6  
Date fired: 10 April 57



Anal Lab, Engr Labs, D&PS  
18 Apr 57 800

D-2  
CONFIDENTIAL

# CONFIDENTIAL

## ANALYTICAL LABORATORY REPORT

## APPENDIX E

### TEST OF:

Shell, HEP, 155mm, T152E5  
and T152E6.

### OBJECT OF TEST:

To obtain vertical target  
accuracy and exterior ballistic  
coefficients.

Report No. 57-AL-46

Date Submitted 21 May 1957

Prepared for Mr. Ralph Allen,

Artillery Ammunition Branch

Dates of Test 10 and 11 April 1957

Project No. TAL-5002H/TE20

Work Order No. 32-236-54

Sheet 1 of 1

Target accuracy and time of flight firings were conducted with Shells, HEP, 155mm, T152E5 and T152E6 to determine form factor and ammunition dispersion on 10 and 11 April 1957, with a vertical target placed at 1000 yards from the muzzle of the gun. The results of the firings are contained in the following table:

Shell	Instrument												Vertical Target	
	Avg Proj Wt. (lbs)	Date Fired (Apr 57)	No. of Rds	Velocity (fps)		Pressure (psi/100)		Time of Flight (sec)	Bal Coef	Form Factor	Accuracy			
				Avg	Std Dev	Avg	Std Dev				P.E. (mils)			
											Vert.	Lat.		
E5	70.55	10	10	1807	3.1	286	3.7	1.78623	2.03	.89	.39	.27		
											.13 <sup>a</sup>			
E5	70.52	10	10	1812	3.5	290	7.2	1.78117	2.02	.90	.34	.32		
F6	77.83	10	10	1824	6.7	312	4.4	1.74858	2.27	.88	.14	.34		
E5	70.62	11	5	-	-	292	3.6	-	-	-	.31	.11		
											.09 <sup>b</sup>			

a. Omitting two maverick rounds.

b. Omitting one maverick round.

Prepared by

W. E. Centey  
W. E. Centey

Reviewed by

Joseph E. Steedman  
Joseph E. Steedman  
Technical Assistant  
Propellant & Target Accuracy  
Section

Approved by

A. E. Karp  
A. E. Karp  
Chief  
Analytical Laboratory

Engineering Laboratories  
Supporting Services  
Development and Proof Services  
Aberdeen Proving Ground, Maryland

E-1

CONFIDENTIAL

ORDBG-677 Rev 25 Sept 52		Program: 155mm Howitzer	
Ordnance Corps Aberdeen Proving Ground Maryland		Proof Officer: Mr. Allen	
SUMMARY OF METEOROLOGICAL DATA		Date 24 June 1957 Time 0929 to 1143 1335 to 1408	
WINDS ALOFT			
Balloon Run No.	Time of Release	Max. Ordinate Required (Ft.)	Max. Ordinate Reached (Ft.)
2 R	0934	15,000	15,000
3 R	1030	15,000	14,154
4 R	1157	15,000	15,000
5 R	1331	15,000	15,000
6 R	1430	15,000	15,000
DENSITIES ALOFT			
Radio Metro Run No.	Time of Release	Max. Ordinate Required (Ft.)	Max. Ordinate Reached (Ft.)
2 R	0934	15,000	15,000
3 R	1030	15,000	14,604
5 R	1331	15,000	15,000
6 R	1430	15,000	15,000

ORDBG-569 Rev. 25 May 46		Page      of      Pages	
Ordnance Corps <b>ABERDEEN PROVING GROUND, MD.</b> <b>METEOROLOGICAL SERVICE</b>		Program <b>155mm Howitzer</b>	
		Proof Off. <b>Mr. Allen</b>	
		Date <b>24 June 1957</b>	
Ascension No.: <b>2 R</b>		Time: <b>0934</b>	
Method Used: <b>GMD-1</b>		Az. Line of Fire: <b>39°00'</b>	
WIND DATA ALOFT			
Time Observed Mins.	Altitude yds.	$\frac{W_x}{m.p.h.}$	$\frac{W_z}{m.p.h.}$
0	0	- 7.7	-2.2
1	332	- 5.0	+1.2
2	750	- 3.0	+4.0
3	1148	- 3.7	+6.7
4	1514	- 6.2	+7.0
5	1908	- 8.5	+6.2
6	2304	-12.4	+2.3
7	2719	-13.9	-2.5
8	3128	-14.9	-2.7
9	3547	-16.0	-3.2
10	3964	-14.5	-4.9
11	4354	-11.2	-7.8
12	4750	-10.4	-7.4
13	5163	-11.1	-4.6
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
SURFACE DATA			
Sky: <b>Scattered Clouds</b>	Temperature: <b>77.8</b>	of	Wind Direction <b>235</b> <sup>(To)</sup>
Visibility: <b>7 miles</b>	Pressure <b>30.04</b>	in	Wind Velocity M.P.H.
Disappearance: <b>Abandoned</b>	Relative Humidity <b>81</b> %		<b>8</b>
	Ballistic Density <b>.977</b>		

ORDBG-569 Rev. 25 May 46		Page      of      Pages	
Ordnance Corps ABERDEEN PROVING GROUND, MD.		Program      155mm Howitzer	
METEOROLOGICAL SERVICE		Proof Off. Mr. Allen	
		Date 24 June 1957	
Ascension No.:      24 June 1957		Time:      1030	
Method Used:      155mm Howitzer		Az. Line of Fire:      39°00'	
WIND DATA ALOFT			
Time Observed Mins.	Altitude yds.	$\frac{W_x}{m.p.h.}$	$\frac{W_z}{m.p.h.}$
0	0	- 7.3	+3.3
1	392	- 4.2	+3.2
2	746	- 4.0	+6.5
3	1077	- 6.6	+6.7
4	1426	-10.8	+5.1
5	1820	-11.8	+3.6
6	2146	-11.5	+0.6
7	2532	-13.3	-2.3
8	2904	-14.3	-4.3
9	3258	-16.0	-4.7
10	3618	-15.5	-5.2
11	3996	-12.6	-5.2
12	4346	-12.4	-4.8
13	4718	-12.8	-4.8
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
SURFACE DATA			
Sky:      Scattered Clouds	Temperature:      83.0	of	Wind Direction (Tc)      195
Visibility:      7 miles	Pressure      30.05	in	Wind Velocity M.P.H.
Disappearance:      Instrument failure	Relative Humidity      69%		8
	Ballistic Density      .968		

ORDBG-569 Rev. 25 May 46		Page of Pages	
Ordnance Corps ABERDEEN PROVING GROUND, MD. METEOROLOGICAL SERVICE		Program 155mm Howitzer	
		Proof Off. Mr. Allen	
		Date 24 June 1957	
Ascension No.: 4 R		Time: 1157	
Method Used: GMD-1		Az. Line of Fire: 39°00'	
WIND DATA ALOFT			
Time Observed Mins.	Altitude yds.	$\frac{W}{X}$ m.p.h.	$\frac{W}{Z}$ m.p.h.
0	0	- 2.9	+ 4.0
1	365	M*	M
2	719	M	M
3	1092	M	M
4	1410	M	M
5	1755	M	M
6	2103	M	M
7	2452	-11.7	- 0.6
8	2800	-12.1	- 2.0
9	3152	-12.8	- 3.1
10	3490	-15.1	- 4.5
11	3832	-16.9	- 5.5
12	4191	-16.7	- 3.5
13	4537	-13.6	+ 0.2
14	4880	-12.3	- 1.1
15	5236	-11.7	+ 0.5
16			
17			
18			
19		* Instrument tracking failure precluded accurate observation at lower levels of sounding.	
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
SURFACE DATA			
Sky: Scattered Clouds	Temperature: 85.0	of	Wind Direction (To) 165
Visibility: 5 miles	Pressure 30.02	in	Wind Velocity M.P.H.
Disappearance: Abandoned	Relative Humidity 66%		5
	Ballistic Density B-5 .963		

ORDBG-569 Rev. 25 May 46		Page      of      Pages	
Ordnance Corps ABERDEEN PROVING GROUND, MD.		Program 155mm Howitzer	
METEOROLOGICAL SERVICE		Proof Off. Mr. Allen	
		Date 24 June 1957	
Ascension No.: 5 R		Time: 1331	
Method Used: GMD-1		Az. Line of Fire: 39°00'	
WIND DATA ALOFT			
Time Observed Mins.	Altitude yds.	W <sub>x</sub> m.p.h.	W <sub>z</sub> m.p.h.
0	0	- 7.9	+1.3
1	409	-13.3	+2.8
2	741	-12.5	+7.6
3	1102	-13.1	+7.0
4	1445	-15.3	+5.4
5	1753	-16.9	+3.0
6	2079	-16.5	+0.2
7	2351	-15.3	-1.6
8	2672	-12.1	-3.3
9	2982	- 9.8	-2.9
10	3313	-11.5	-3.0
11	3591	-13.4	-2.1
12	3915	-13.5	-2.0
13	4268	-13.8	-1.7
14	4620	-12.4	+0.1
15	4973	- 9.7	+0.4
16	5333	-10.2	+0.6
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
SURFACE DATA			
Sky: Scattered Clouds	Temperature: 87.0	of	Wind Direction (To) 210
Visibility: 5 miles	Pressure 30.00	in	Wind Velocity M.P.H.
Disappearance: Abandoned	Relative Humidity 60 %		8
	Ballistic Density .959		

ORDBG-569 Rev. 25 May 46		Page      of      Pages	
Ordnance Corps ABERDEEN PROVING GROUND, MD: METEOROLOGICAL SERVICE		Program    155mm Howitzer	
		Proof Off. <u>Mr. Allen</u>	
		Date <u>24 June 1957</u>	
Ascension No.:      6 R		Time:      1430	
Method Used:      GD-1		Az. Line of Fire:      39°00'	
WIND DATA ALOFT			
Time Observed Mins.	Altitude yds.	$\frac{W_x}{m.p.h.}$	$\frac{W_z}{m.p.h.}$
0	0	-10.0	-0.2
1	460	-16.1	+4.5
2	828	-18.1	+6.4
3	1238	-19.5	+4.3
4	1586	-18.7	+2.3
5	1954	-16.8	+0.4
6	2370	-14.8	-1.0
7	2827	-11.1	-1.5
8	3204	-10.1	-1.4
9	3653	-12.6	-1.1
10	4045	-14.8	-0.3
11	4470	-14.0	+2.2
12	4881	- 8.9	+3.5
13	5298	- 8.6	+0.5
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
SURFACE DATA			
Sky:      Scattered Clouds	Temperature:      87.4	of	Wind Direction      (To)      220
Visibility:      5 miles	Pressure      29.98	in	Wind Velocity M.P.H.
Disappearance:	Relative Humidity      63	%	10
	Ballistic Density      .987		

Development & Proof Services  
Aberdeen Proving Ground, Md.

TEMPERATURES AND DENSITIES ALOFT

Program <b>155mm Howitzer</b>		Date <b>24 June 1957</b>
Proof Director <b>Mr. Allen</b>		Radio Meteorograph Run Number <b>2 R</b>
Time Released <b>0934</b>		Time Reached Altitude <b>0947</b>
ALTITUDE YARDS	TEMPERATURE °F	RELATIVE DENSITY
0	77.8	.977
190	71	.989
383	69	.990
579	69	.988
779	68	.989
983	68	.987
1191	66	.990
1402	63	.993
1618	60	.998
1836	58	.998
2060	55	1.000
2287	54	1.000
2520	51	1.001
2757	48	1.006
2999	45	1.008
3247	42	1.009
3500	40	1.009
3759	39	1.008
4025	37	1.006

<p align="center"><b>Development &amp; Proof Services</b>  <b>Aberdeen Proving Ground, Md.</b>  <b>TEMPERATURES AND DENSITIES ALOFT</b></p>		
Program <b>155mm Howitzer</b>		Date <b>24 June 1957</b>
Proof Director <b>Mr. Allen</b>		Radio Meteorograph Run Number <b>2 R</b>
Time Released <b>0934</b>		Time Reached Altitude <b>0947</b>
ALTITUDE YARDS	TEMPERATURE °F	RELATIVE DENSITY
4298	35	1.007
4579	32	1.008
4867	29	1.008
5163	28	1.003

Development & Proof Services  
Aberdeen Proving Ground, Md.

TEMPERATURES AND DENSITIES ALOFT

Program <b>155mm Howitzer</b>		Date <b>24 June 1957</b>
Proof Director <b>Mr. Allen</b>		Radio Meteorograph Run Number <b>3 R</b>
Time Released <b>1030</b>		Time Reached Altitude <b>1043</b>
ALTITUDE YARDS	TEMPERATURE °F	RELATIVE DENSITY
0	83.0	.968
192	77	.979
386	70	.991
582	69	.991
782	68	.989
986	69	.987
1194	67	.989
1406	64	.991
1621	61	.995
1840	57	1.001
2063	56	1.000
2291	54	1.001
2523	52	1.001
2760	48	1.006
3002	46	1.008
3250	43	1.009
3503	40	1.010
3761	37	1.012

Development & Proof Services  
Aberdeen Proving Ground, Md.

TEMPERATURES AND DENSITIES ALOFT

Program	155mm Howitzer	Date	24 June 1957
Proof Director	Mr. Allen	Radio Meteorograph Run Number	3 R
Time Released	1030	Time Reached Altitude	1043
ALTITUDE YARDS	TEMPERATURE °F	RELATIVE DENSITY	
4027	38	1.006	
4300	35	1.007	
4580	32	1.008	
4868	29	1.008	

**Development & Proof Services  
Aberdeen Proving Ground, Md.**

**TEMPERATURES AND DENSITIES ALOFT**

Program <b>155mm Howitzer</b>		Date <b>24 June 1957</b>
Proof Director <b>Mr. Allen</b>		Radio Meteorograph Run Number <b>5 R</b>
Time Released <b>1331</b>		Time Reached Altitude <b>1347</b>

ALTITUDE YARDS	TEMPERATURE °F	RELATIVE DENSITY
0	87.0	.959
194	82	.965
391	79	.971
591	77	.973
794	74	.976
1001	71	.981
1210	69	.983
1424	67	.986
1641	65	.986
1863	63	.988
2089	60	.992
2319	57	.995
2553	55	.997
2792	51	1.001
3037	48	1.002
3286	45	1.006
3540	42	1.006
3802	41	1.005

Development & Proof Services  
Aberdeen Proving Ground, Md.

TEMPERATURES AND DENSITIES ALOFT

Program <b>155mm Howitzer</b>		Date <b>24 June 1957</b>
Proof Director <b>Mr. Allen</b>		Radio Meteorograph Run Number <b>5 R</b>
Time Released <b>1331</b>		Time Reached Altitude <b>1347</b>
ALTITUDE YARDS	TEMPERATURE °F	RELATIVE DENSITY
4070	39	1.004
4345	36	1.006
4627	36	1.001
4918	33	1.002
5217	30	1.003

Development & Proof Services  
Aberdeen Proving Ground, Md.

TEMPERATURES AND DENSITIES ALOFT

Program 155mm Howitzer		Date 24 June 1957
Proof Director Mr. Allen		Radio Meteorograph Run Number 6 R
Time Released 1430		Time Reached Altitude 1443
ALTITUDE YARDS	TEMPERATURE °F	RELATIVE DENSITY
0	87.4	.957
194	80	.969
391	80	.970
591	77	.972
794	74	.976
1000	72	.980
1210	70	.981
1424	67	.985
1641	64	.988
1862	61	.992
2087	58	.995
2317	55	.998
2550	53	.999
2790	51	.999
3034	49	1.001
3284	46	1.001
3540	46	.999
3802	42	1.002
4071	41	1.001
4347	38	1.003
4630	36	1.002

## TEMPERATURES AND DENSITIES ALOFT

Program 155mm Howitzer		Date 24 June 1957
Proof Director Mr. Allen		Radio Meteorograph Run Number 6 R
Time Released 1430		Time Reached Altitude 1443
ALTITUDE YARDS	TEMPERATURE °F	RELATIVE DENSITY
4921	33	1.001
5220	29	1.003

ENGINEERING LABORATORIES  
PHYSICAL TEST LABORATORY REPORT

ORDBG-DP-LP

TITLE:

Metallurgical and  
Chemical Analysis of Armor  
from German Royal Tiger  
Tank Hull.

Report No. 57-P-45

Sheet 1 of 3

Date of Test 18 June - 26 July 1957

Report Completed 7 August 1957

OBJECT OF TEST:

To determine physical  
properties, metallurgical  
structure, and chemical  
composition of the 6" armor.

Conducted for Mr. R. Allen,

Artillery Division

Project No. TAL-5002H/TE20

INTRODUCTION:

The project engineer requested that these tests be conducted on a section of hull armor from the upper front plate of a German Royal Tiger tank hull. These hulls were shipped to APG from the factory where they were captured near the end of World War II. They have been used in various tests where armor was desired, but no particular quality was required. A test has been conducted recently, however, in which performance of a round is being evaluated, and the question arose as to the quality of the armor in the hull. Since no data on this armor was available, the metallurgical and chemical analyses were requested.

References Military Specification

MIL-A-12560 (Ord)

TEST PROCEDURE:

1. A section approximately 15" square was flame cut from the upper front plate. Cross-sectional plates were sawed from this section, at right angles to each other, for a macroetch test to determine the major direction of rolling. These were designated "X" and "Y" and were selected at least 4" from any flame-cut surface. The plates were given a hot acid macroetch in 50% HCl.

2. Three standard Charpy "V" Notch Specimens and one standard 0.505" diameter tensile bar were machined from each of the above plates and designated as "X" and "Y", according to the plate from which machined (see photographs, Appendix II for location of test specimens). Tensile and Charpy impact data were obtained. Brinell hardness readings were taken through the cross-section of each plate.

3. Specimens were mounted in bakelite, polished, etched and examined under high magnification. Photomicrographs are included in Appendix II.

4. Drillings were obtained through the cross-section of the armor and sent to the Coating and Chemical Laboratory for the chemical analysis.

#### RESULTS:

1. The macroetched plates showed the armor to be free of large laminations, seams, cracks, porosity, or other serious macro-defects. The plate appeared to be cross-rolled but the major direction of rolling could not be determined, since both directions had about the same appearance. The relatively intact dendritic structure indicates that working was not severe (see photographs, Appendix II).

2. Mechanical test data follows:

##### a. Charpy "V" Notch Impact Data

<u>Spec. No.</u>	<u>Breaking Temp, °F</u>	<u>Energy Absorbed ft-lbs</u>	<u>Fracture Appearance*</u>
Y1	70	35.0	40S, 60C
X1	70	28.5	30S, 70C
Y2	-40	7.0	100C
X2	-40	5.0	100C
Y3	200	42.0	50S, 50C
X3	200	43.0	50S, 50C

\* "S" denotes shear; "C" denotes cleavage type of fracture.

##### b. Tensile Test Data (See Appendix I for Stress-Strain Curves)

<u>Spec. No.</u>	<u>Yield Strength (.1% offset, psi)</u>	<u>Tensile Strength psi</u>	<u>% Elong. in 2"</u>	<u>% Reduction in Area</u>
X	89,500	118,250	19.5	53.7
Y	89,000	118,000	21.0	56.3

##### c. BHN, 3000 Kg

<u>Spec. No.</u>	<u>No. Readings</u>	<u>Range</u>	<u>Average</u>
X	6	235-255	248
Y	6	241-255	244

3. Viewing the microsample in the unetched condition revealed this armor to be clean and largely free from non-metallic inclusions. A few scattered, elongated inclusions were noted, probably of MnS. The etched samples showed the microstructure to be fairly coarse tempered martensite. Some

ferrite was present and fairly noticeable banding was present. (See photomicrographs, Appendix II).

4. Results of the Chemical Analysis follow:

Carbon	0.43%
Manganese	0.43
Silicon	0.33
Sulfur	0.019
Phosphorus	0.024
Nickel	0.14
Chromium	2.17
Molybdenum	0.22
Vanadium	0.01

DISCUSSION:

1. A comparison of the results of this analysis against the requirements of the current U.S. Military Specification for wrought armor leads to the following observations:

- a. The armor tested is within the specification for hardness.
- b. Carbon content is higher than the specified maximum.
- c. Charpy impact values are far below those required for armor plate of this thickness and hardness.

2. Since the steel is clean, sound, and has enough alloy content to be in the armor class, it appears that the poor impact resistance largely results from the heat treatment. The presence of some high temperature transformation products, coarse structure, and fairly high carbon content contribute to the poor impact values.

CONCLUSION:

The plate investigated should be considered poor quality armor.

2 Incls.  
Appendix I  
Appendix II

Approved: J. M. McKinley  
J. M. McKinley,  
Chief  
Physical Test Laboratory

Signed: R. L. Huddleston  
R. L. Huddleston,  
Chief  
Rad. & Mat. Section

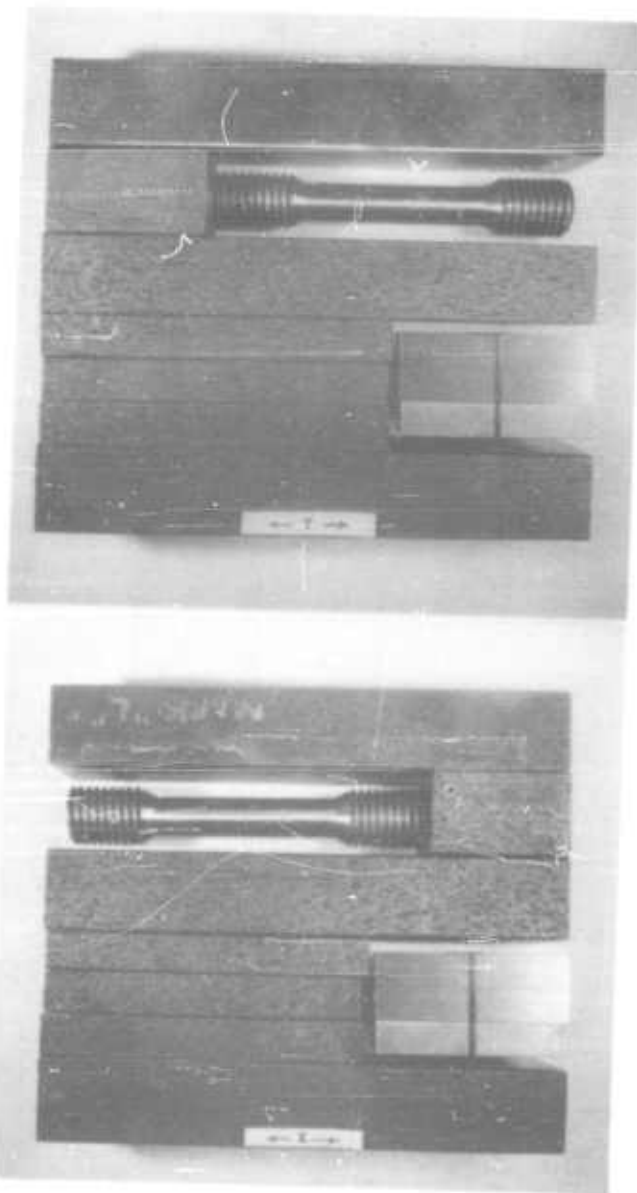
STRESS-STRAIN CURVES  
FOR SPECIMENS X AND Y,  
GERMAN "ROYAL TIGER"  
TANK HULL FRONT PLATE.  
(SPECIMENS 0.535" DIA., 2.0 GA. THK.)

T.S. = 118,000 PSI

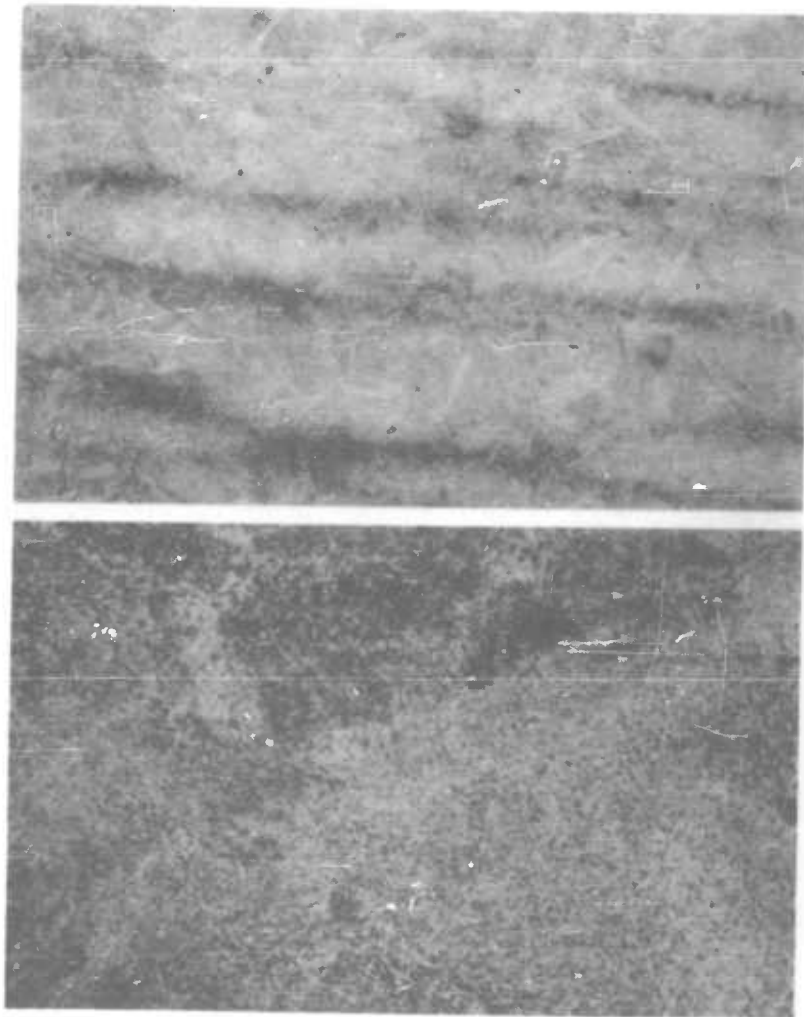
T.S. = 118,250 PSI

Stress, PSI  $\times 10^3$ Y.S. (1% OFFSET) =  
69,500 PSIY.S. (1% OFFSET) =  
69,000 PSISPECIMEN X  
SPECIMEN YSTRAIN, IN./IN.  $\times 10^{-3}$ 

Appendix I E-19



Approx. 1X. Macroetched "X" and "Y" cross-sections showing location of test specimens. "X" and "Y" sections were selected normal to each other.



Top: 250X (Picral Etch). Microstructure showing tempered structure, banding, and scattered inclusions.

Bottom: 750X (Picral Etch). Tempered martensitic structure.

155 mm Howitzer Tube, M1

[illegible]

CHAMBER  
0.00" to 28.70" (BASIC)

W. O. 22-603-40





ORDG-859K (Reinst 22 Mar 55)		155 mm Howitzer Tube, M1								
CASTING NUMBER		Main Bore - 29.70" to 142.80"								
MANUFACTURER		Gauge Meas. indicated in 1/1000 of an inch								
MODEL		Distance (Inches) From	Rear Face of Breech Howitzer	Muzzle Face of Tube	Rear Face of Tube	6.100" Basic Diameter	6.200" Basic Diameter			
NUMBER					Vert.	Hor.	Vert.	Hor.		
155 Howitzer Tube	2199	M1	PROOF OFFICER M. O. 302-236-54	149.10	.10	142.70	7.001	7.002	7.005	7.005
				148	1.20	141.60	1	2	5	5
				147	2.20	140.60	1	1	5	5
				145	4.20	138.60	1	1	5	5
				140	9.20	133.60	1	1	5	5
				135	14.20	128.60	1	1	5	5
				130	19.20	123.60	1	1	5	5
				125	24.20	118.60	1	1	5	5
				120	29.20	113.60	1	1	5	5
				115	34.20	108.60	1	1	5	5
				110	39.20	103.60	1	1	5	5
				105	44.20	98.60	1	1	5	5
				100	49.20	93.60	1	1	5	5
				95	54.20	88.60	1	1	5	5
				90	59.20	83.60	1	1	5	5
				85	64.20	78.60	1	1	5	5
				80	69.20	73.60	1	1	5	5
				75	74.20	68.60	1	1	5	5
				70	79.20	63.60	1	1	5	5
				65	84.20	58.60	1	1	5	5
				60	89.20	53.60	1	1	5	5
				54.40	94.80	48.00	1	1	5	5
				50	99.20	43.60	2	1	5	5
				48.30	100.90	41.90	2	2	5	5
				46	103.20	39.60	2	2	5	5
				44	105.20	37.60	3	2	5	5
				42.20	107.00	35.80	3	2	5	5
				40	109.20	33.60	3	3	5	5
				39.10	110.10	32.70	4	3	5	5
				38.10	111.10	31.70	5	3	6	5
37.10	112.10	30.70	6	5	7	5				
36.50	112.70	30.10	8	6	8	6				
36.20	113.00	29.80	7.002	7.009	7.010	7.003				
MOUNTED IN HOWITZER										
DATE OF GAUGING										
1 July 1957										

CHAMBER  
0.00" to 28.70" (BASIC)

W. O. 332-236-54

OBSG--866 6 OCT 49 (FORMERLY SPOTZ--661)				METEOROLOGICAL SERVICE			DATE 10 April 1957		
SURFACE DATA									
155mm Howitzer				Mr. Allen					
MAXIMUM TEMPERATURE				MINIMUM TEMPERATURE			MEAN TEMPERATURE		
TIME	WIND VEL.	WIND DIR. (From)		WEATHER	VISIBILITY	TEMP.	SEA LEVEL PRESSURE	REL. HUM.	RELATIVE DENSITY
	M.P.H.		AZ.					%	
1 0945	11	WNW	110	Clear	15+	53.1	30.07	44	1.033
2 1005	12	W	100	(Setd) Thin Clds.	15+	52.6	30.07	40	1.035
3 1016	11	WSW	070	(Setd) Thin Clds.	15+	52.8	30.07	39	1.034
4 1025	8	WSW	070	(Setd) Thin Clds.	15+	52.5	30.06	40	1.034
5 1030	9	WSW	070	(Setd) Thin Clds.	15+	52.6	30.06	40	1.034
6 1035	14	WSW	070	Setd clds	15+	53.5	30.06	39	1.032
7 1105	10	SSW	025	Setd clds	15+	55.0	30.06	37	1.029
8 1115	8	SSW	025	Setd clds	15+	55.1	30.06	38	1.029
9 1120	15	WSW	070	Setd clds	15+	55.6	30.06	36	1.028
10 1130	10	WSW	070	Setd clds	15+	55.4	30.06	36	1.028
11 1140	10	WSW	070	Setd clds	15+	55.4	30.05	37	1.028
12 1143	14	W	100	Setd clds	15+	55.1	30.05	38	1.029
13 1145	12	WNW	155	Setd clds	15+	55.2	30.05	38	1.028
14 1147	10	WNW	155	Setd clds	15+	55.4	30.05	36	1.028
15 1150	18	NW	140	Setd clds	15+	55.5	30.05	35	1.028
16 1152	10	NW	140	Setd clds	15+	55.0	30.05	35	1.029
17 1155	8	WNW	110	Setd clds	15+	55.2	30.05	34	1.028
18 1353	9	WNW	110	Setd clds	15+	57.1	30.02	35	1.023
19 1400	10	W	100	Setd clds	15+	57.2	30.02	33	1.023
20 1405	8	W	100	Setd clds	15+	57.4	30.02	34	1.023
21 1406	9	W	100	Setd clds	15+	57.2	30.02	33	1.023
22 1411	12	WNW	110	Setd clds	15+	56.8	30.02	32	1.024
23 1420	18	WNW	110	Setd clds	15+	56.6	30.02	31	1.025
24 1422	14	WNW	110	Setd clds	15+	56.7	30.02	30	1.025
25 1424	12	WNW	110	Setd clds	15+	56.5	30.02	31	1.025

DATE 10 April 1957

**SURFACE DATA**

155mm Howitzer

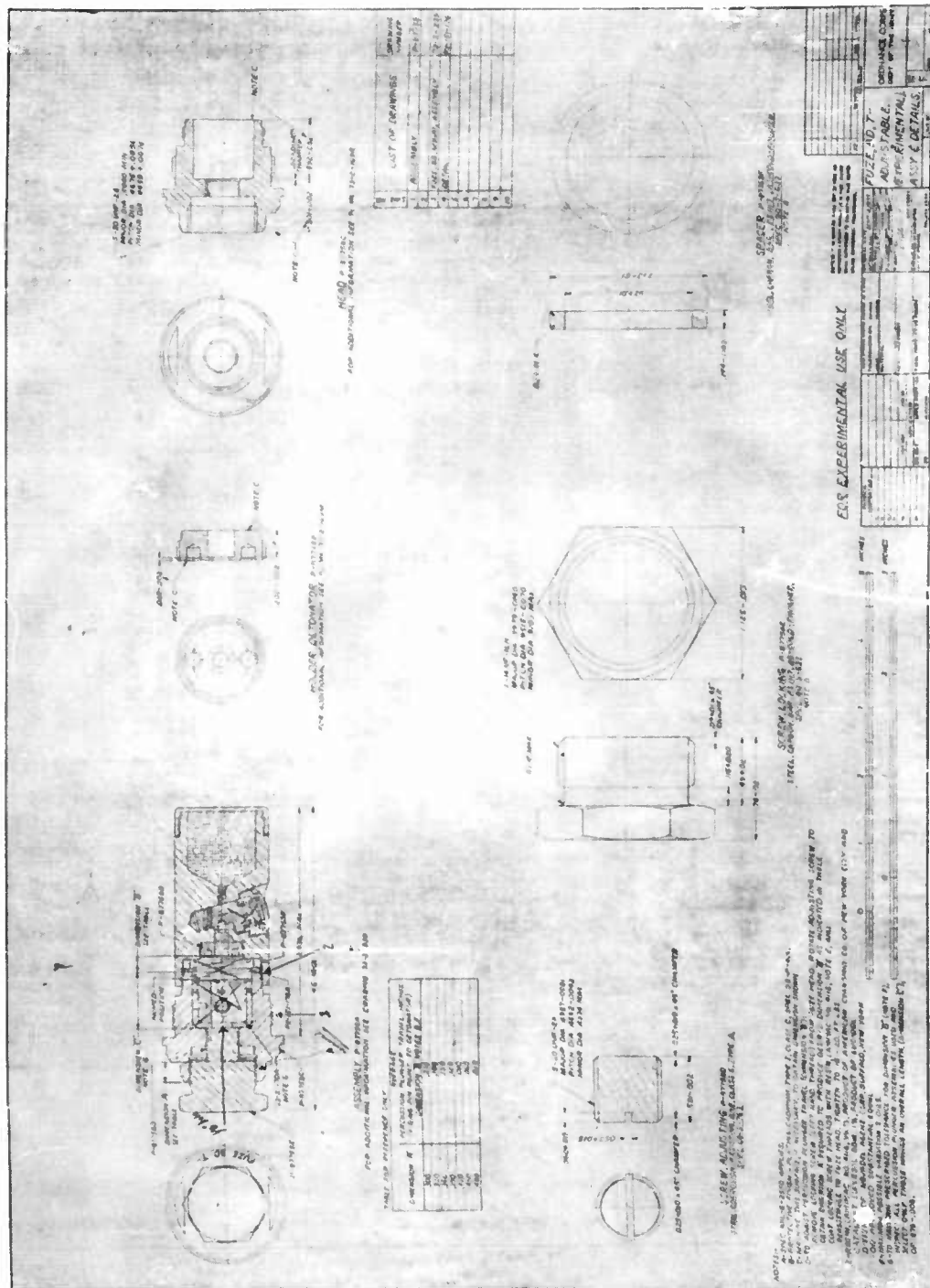
Mr. Allen

E-29

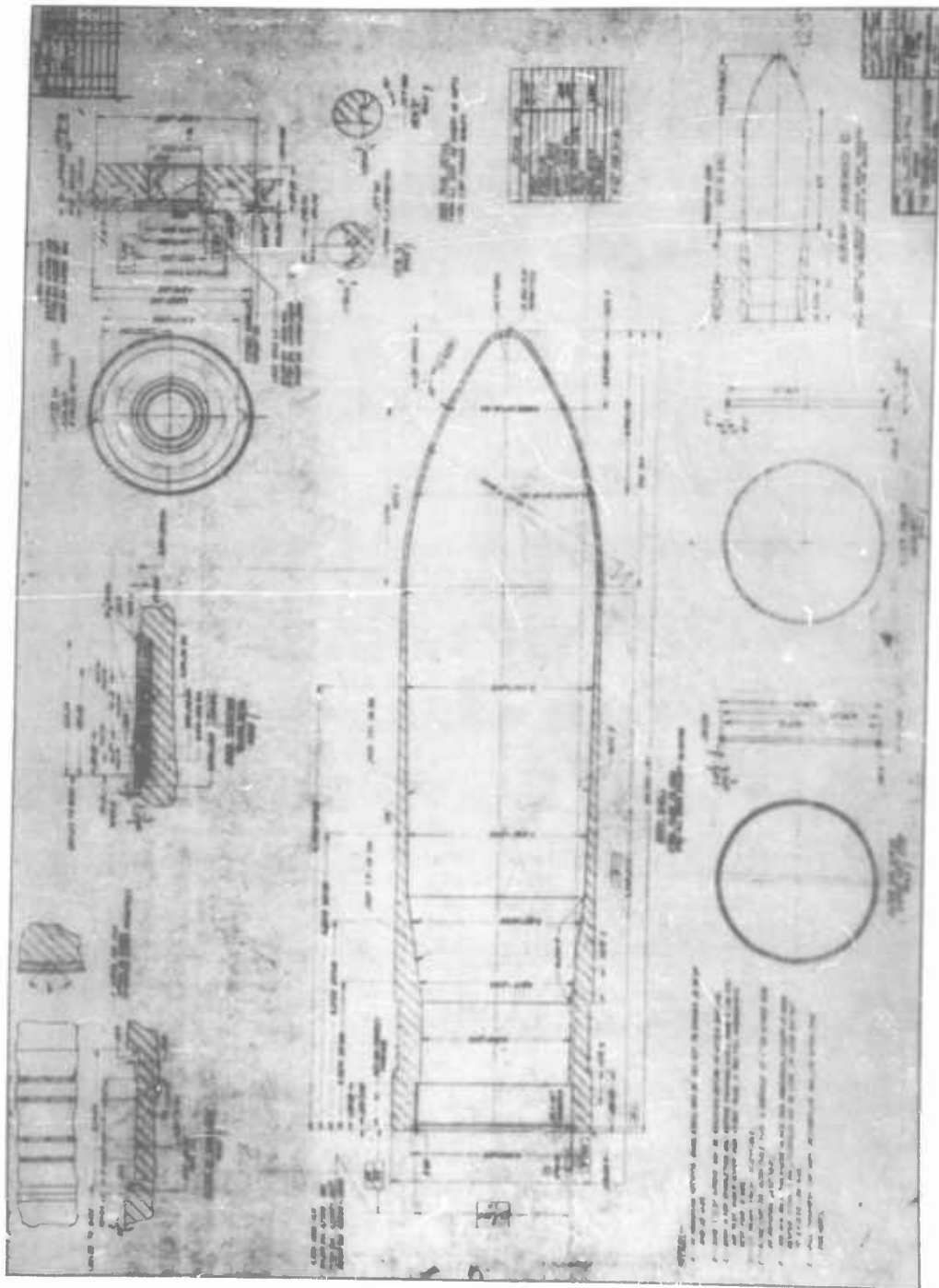


CONFIDENTIAL

## APPENDIX F



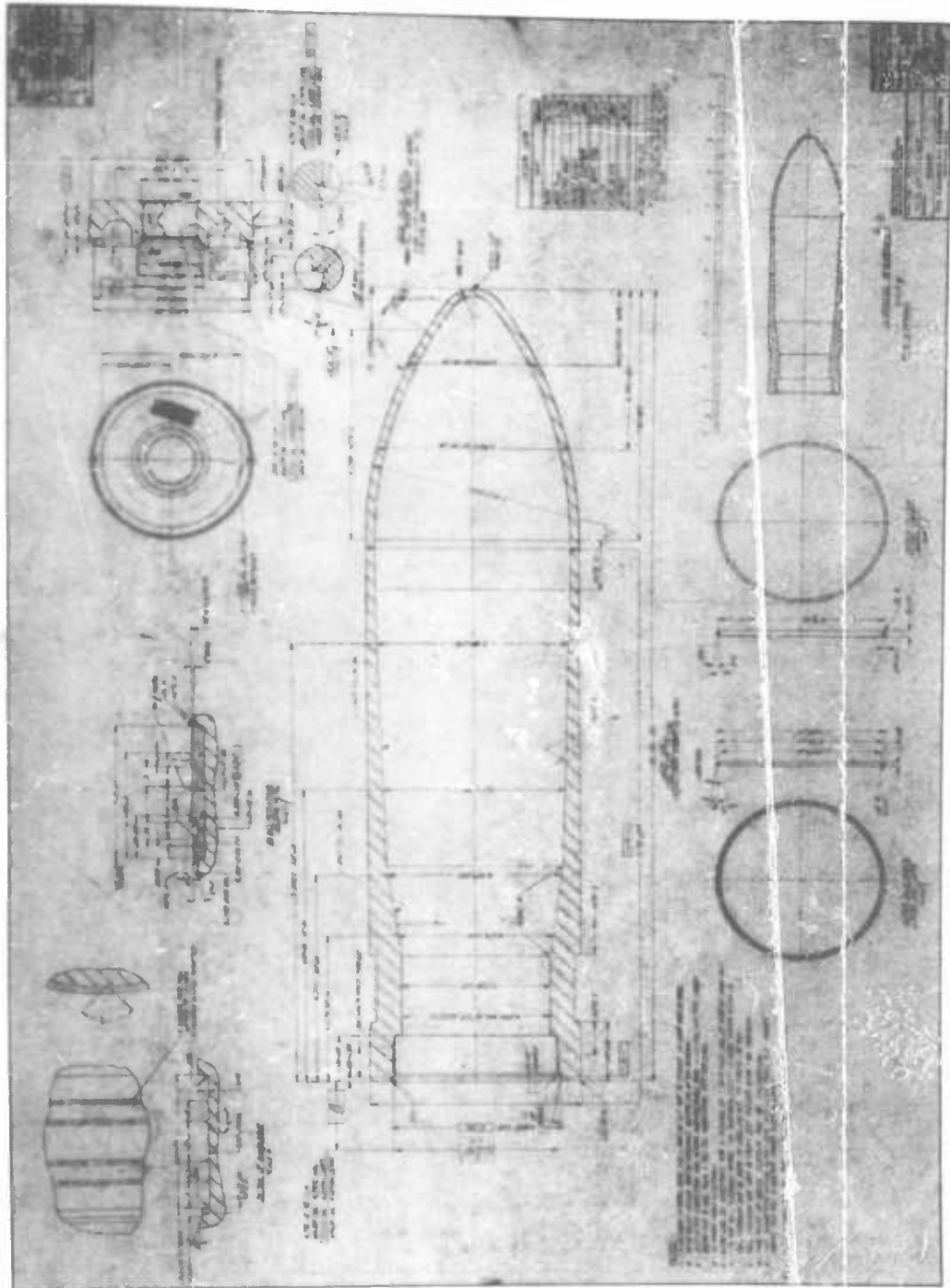
CONFIDENTIAL



F-2

CONFIDENTIAL

CONFIDENTIAL



F-3  
CONFIDENTIAL

**UNCLASSIFIED**

**UNCLASSIFIED**